

ЛУЧШИЕ ПУБЛИКАЦИИ 1960-Х

OCTOBER 50c
VOL. 1, NO. 11

SPACE WORLD

The Magazine of Space News



40 BILLION DOLLARS - Is President Kennedy throwing it away
trying to put American men into space?



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WILLY LEY REVEALS THE FULL STORY-

The Russian 'Murders' In Outer Space

SPACE WORLD

The magazine of space news • OCTOBER 1961

CONTENTS

- 12 MURDER IN OUTER SPACE**, by Willy Ley
The full story about reputed 'deaths' in Russia's space program.
- 16 MACRO-LIFE**, by Dandridge Cole
Part II of a leading engineer's ideas about the destiny of man.
- 18 WOOMERA**
A picture report on England's new Australian missile test range.
- 20 WHY THEY REJECT THE SPACE AGE**, by R. C. Southern
Some reasons why so many people fail to accept the new era.
- 23 SPACE CARTOONIST**, by John Rublowsky
Humorous satellites are created by a prominent space engineer.
- 26 LEARNING TO LIVE ON THE MOON**, by James Gaume
A lunar simulator that helps to prepare men for moon survival.
- 30 POWER FOR INTERPLANETARY TRAVEL** by Max Hunter and Edward Bonnett
Advanced propulsion systems will take spaceships to the planets.
- 35 CAPE CARNIVAL**, by Ernest Haussman
Publicity hoopla has made a circus of our leading space port.
- 38 PICTURE NEWS**
A photographic report on the month's new developments in space.
- 40 THE 40 BILLION DOLLAR QUESTION**, by Otto O. Binder
Will the man-in-space program be worth the money it will cost?
- 47 HOW TO MAKE A MOONWATCH TELESCOPE**
See the satellites with this inexpensive, easy-to-make scope.

DEPARTMENTS

- | | | | |
|-------------------|----|----|----------------------------|
| WHAT'S NEW | 5 | 43 | BOOK REVIEWS |
| ORBITING AROUND | 6 | 45 | SPACE VEHICLE #5: REDSTONE |
| QUESTION BOX | 8 | 49 | SPACE QUIZ |
| JETS AND ROCKETS | 22 | 51 | RUSSIAN REPORT |
| NAMES IN THE NEWS | 34 | 67 | SPACEWORD PUZZLE |

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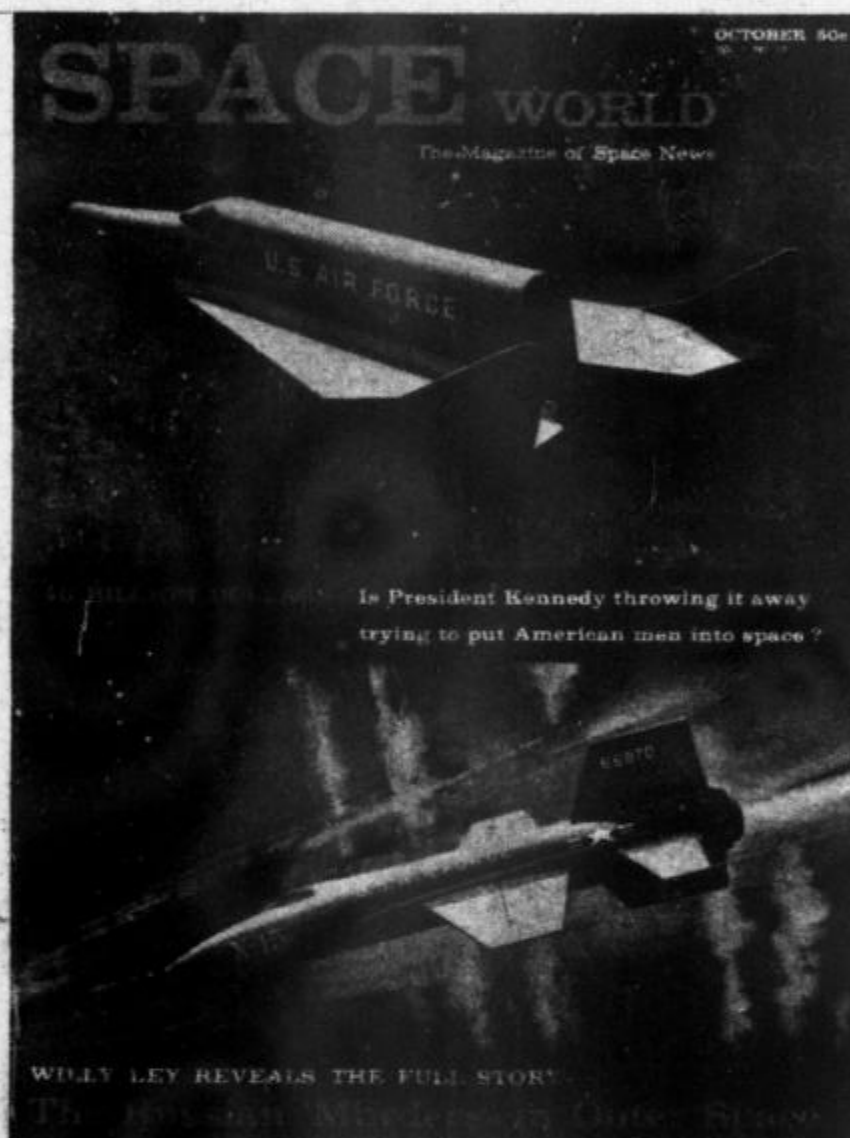
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On The Cover. With President Kennedy's announcement that our space program is being shifted into high gear, both the X-15 and the Dyna-Soar have come into the news. Both of these vehicles are manned and operatable by man. Art courtesy of the Minneapolis-Honeywell Co.



President Kennedy awards medal to Alan Shepard, whose flight marked the first step in our costly man-in-space project.

THE 40 BILLION DOLLAR Q

by OTTO O. BINDER

“What is the advantage in going to the moon?” . . . “All that money could be put to better use right here on this planet.” . . . “What can they [the lunar-nauts] do when they get there?”

These are typical replies of the man-in-the-street in a recent Gallup Poll which asked if America should use what resources are necessary to put a man on the moon. The poll was taken shortly after President Kennedy exhorted U.S. citizens to support a man-in-space program including a “moon race” with the Russians.

The results, excluding 9 percent with no opinion, came out 58 percent against, 33 percent for the President’s proposal.

The Gallup Poll question was put this way: “It has been estimated that it would cost the U.S. 40 billion dollars—or an average of about \$225 per person—to send a man to the moon. Would you like to see this amount spent for this purpose, or not?”

Since the President implied we are going to try to beat the Russians to the moon (their lunar target date is 1967), that means almost \$6 billion a year will be spent on this project in the next 7 years. A truly staggering sum—if the Gallup Poll stated the figures correctly.

Other answers from typical Americans include com-

ments that those same forty billions spent in other ways would “buy a lot of groceries” . . . “mean better schools for my kids” . . . “easily take care of old-age security and a national medical-care program” . . . “wipe out depressed areas” . . . and so on.

So apparently a majority of Americans are opposed to launching what amounts to a semi-crash program to place a man on the moon before the Russians do.

Scientific Reaction

“For the same money you could support a hundred research projects for 40 years . . . in physics, chemistry and biology . . . we need to finish the job of handling arthritis . . . to know more about the genetics of viruses,” says Dr. Vannevar Bush.

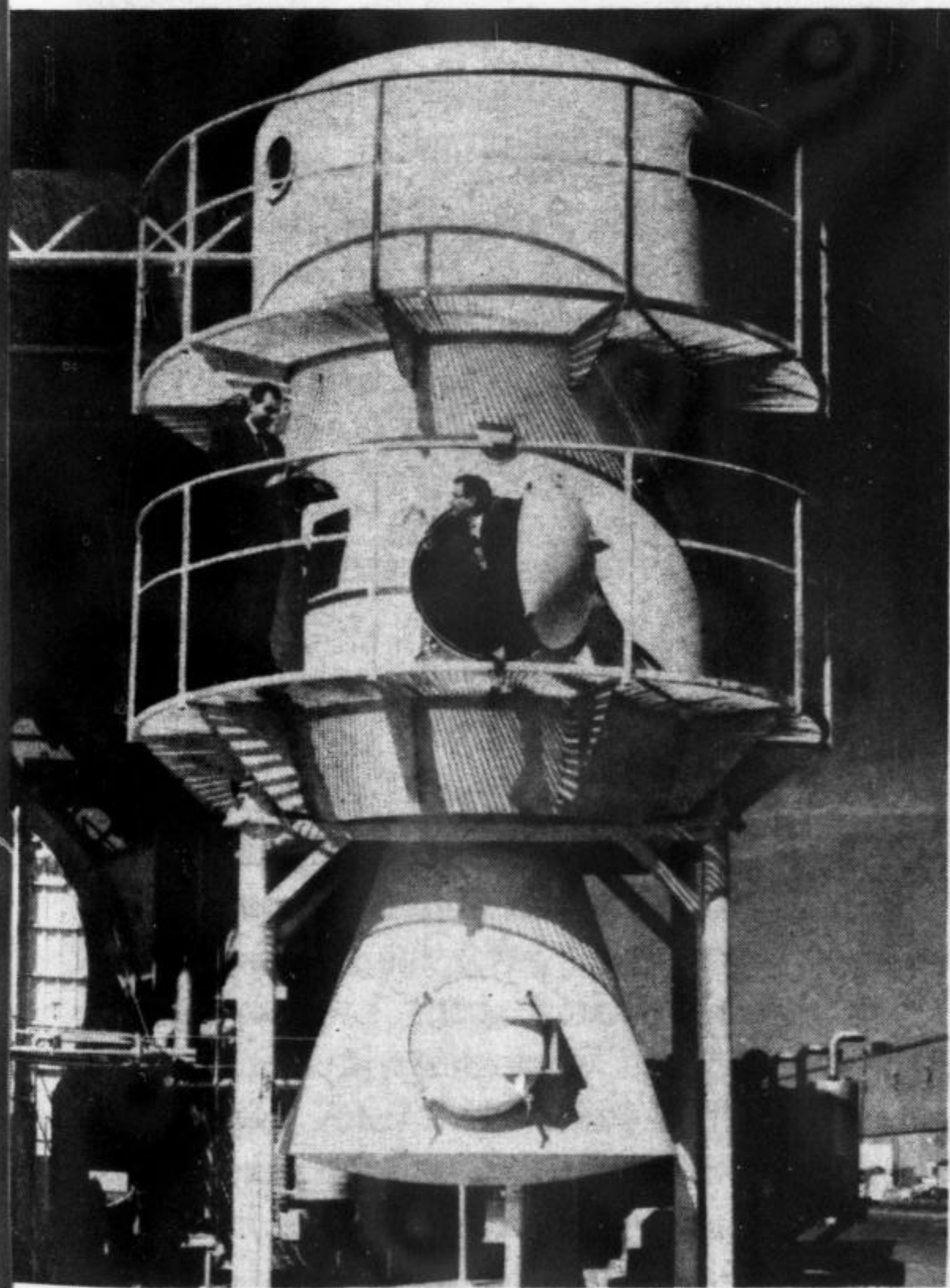
All this is better, Dr. Bush insists, than “shooting it into space.” The remarkable aspect of this comment from a well-known scientist is that Dr. Bush was one of the directors of World War II’s Manhattan Project, a “reaching for the moon” program which produced the atomic bomb. This eventually led, as everyone knows—including Dr. Bush—to peacetime atomic power, radioisotopes in medicine, and many benefits of nuclear science yet to come.

Alvin M. Weinberg, Director of Oak Ridge National Laboratory, agrees with Dr. Bush. Is it wise, Dr. Weinberg wonders, to choose manned flight into space as the primary event in the “Scientific Olympic Games”?

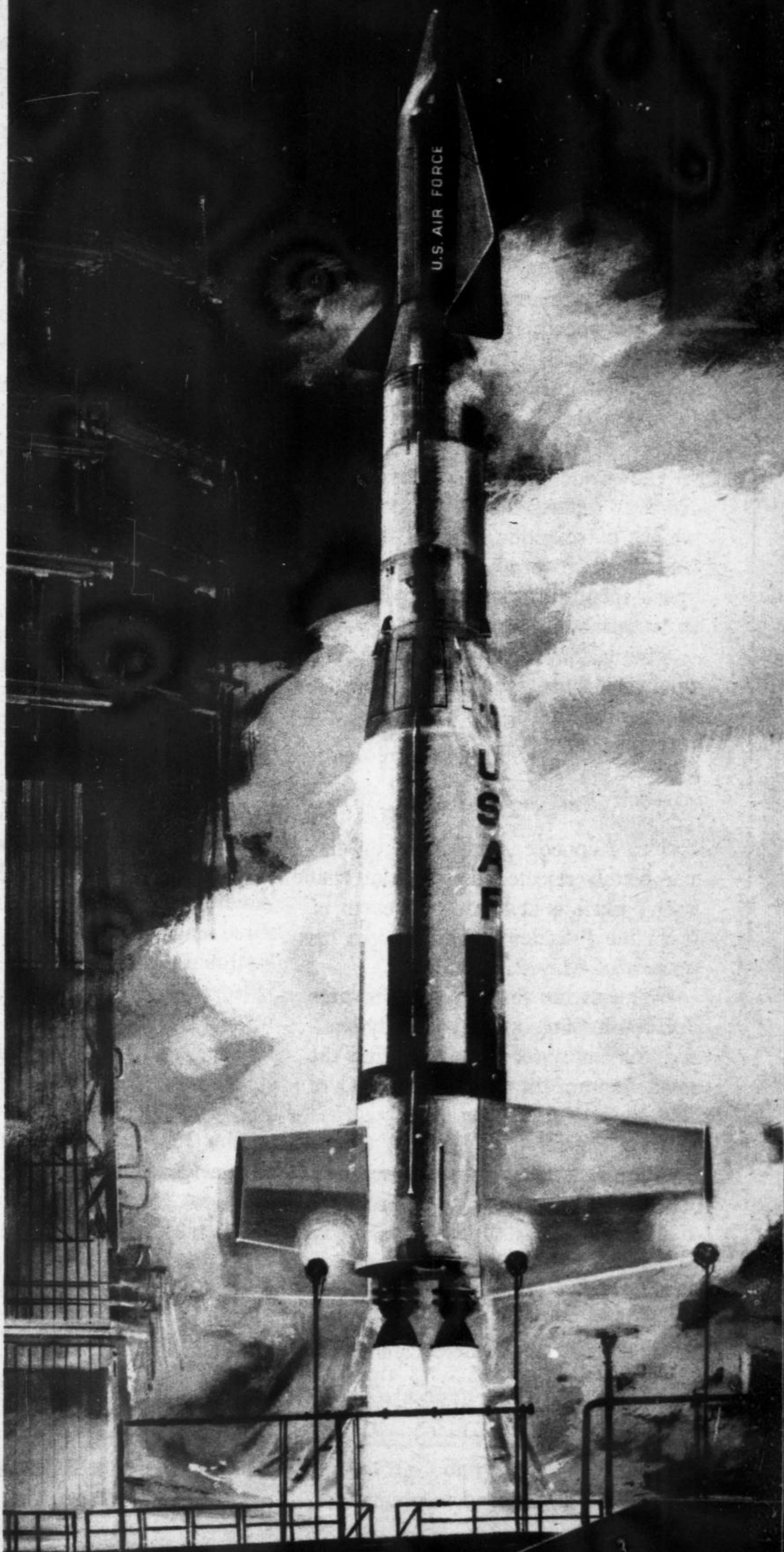
(continued on page 42)

Pres. Kennedy announced a crash effort to reach the moon before the Russians. Will his program be worth the huge sum it will cost?

R QUESTION



Expensive projects. Dyna-Soar, right, and 3-man space station, above, are just two projects that must be completed in order to catch up to Russians.



MACRO- LIFE

PART TWO

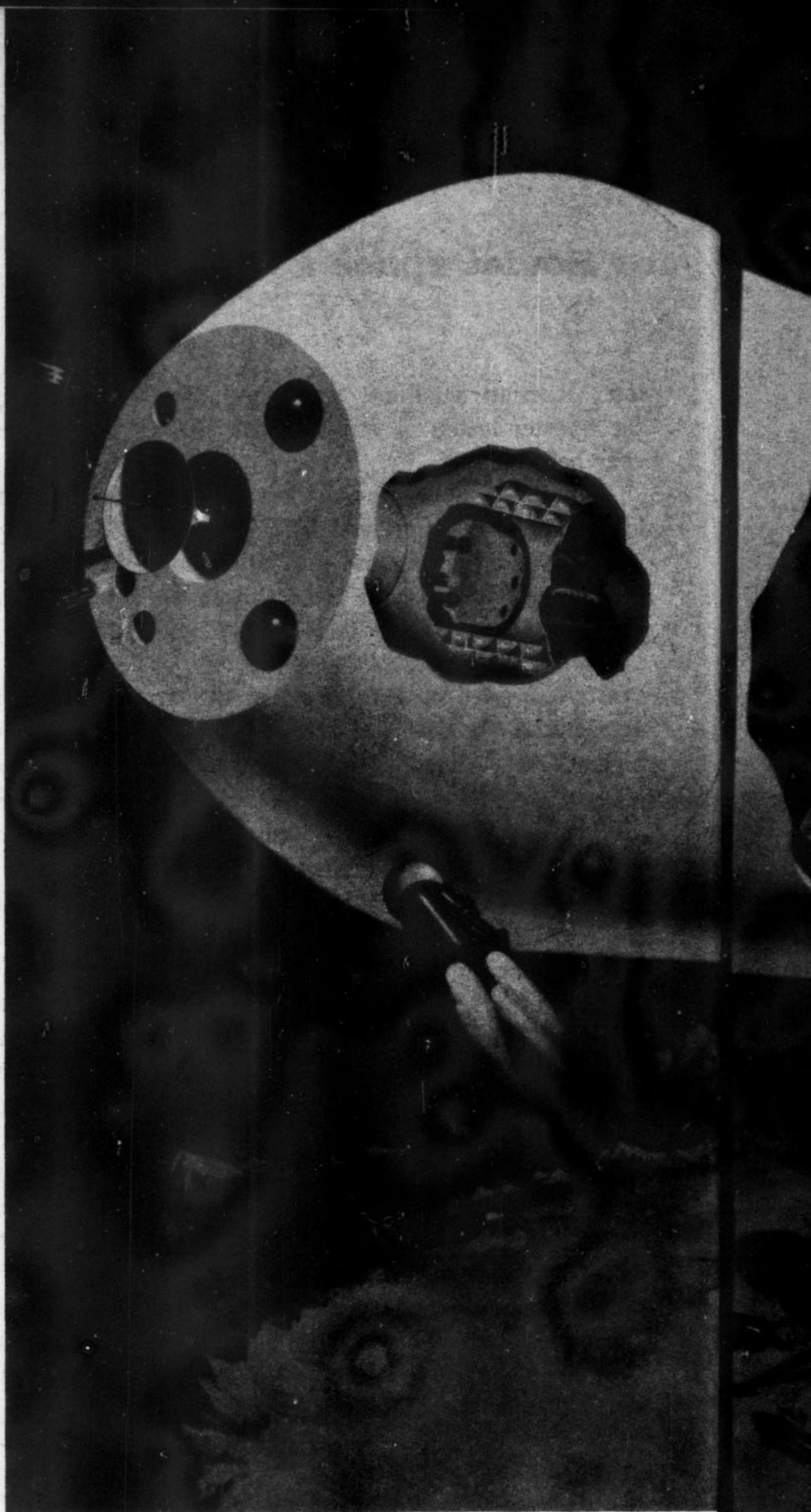
by DANDRIDGE COLE

While the most perfect example of Macro Life which can be expected in the near future is the extra-terrestrial colony or the giant space ship, other varieties will soon appear on earth. In general these preliminary and experimental steps toward the new category of life forms will lack the ability to move and will probably not be completely self-sustaining because of the ease of resupply from elsewhere on earth. Also, they will not have the ability to reproduce unless special provision is made for this function.

While almost any isolated group of human beings has some of the attributes of the new life form, it is only in some very recent or near future developments that we begin to see the emergence of a new super entity.

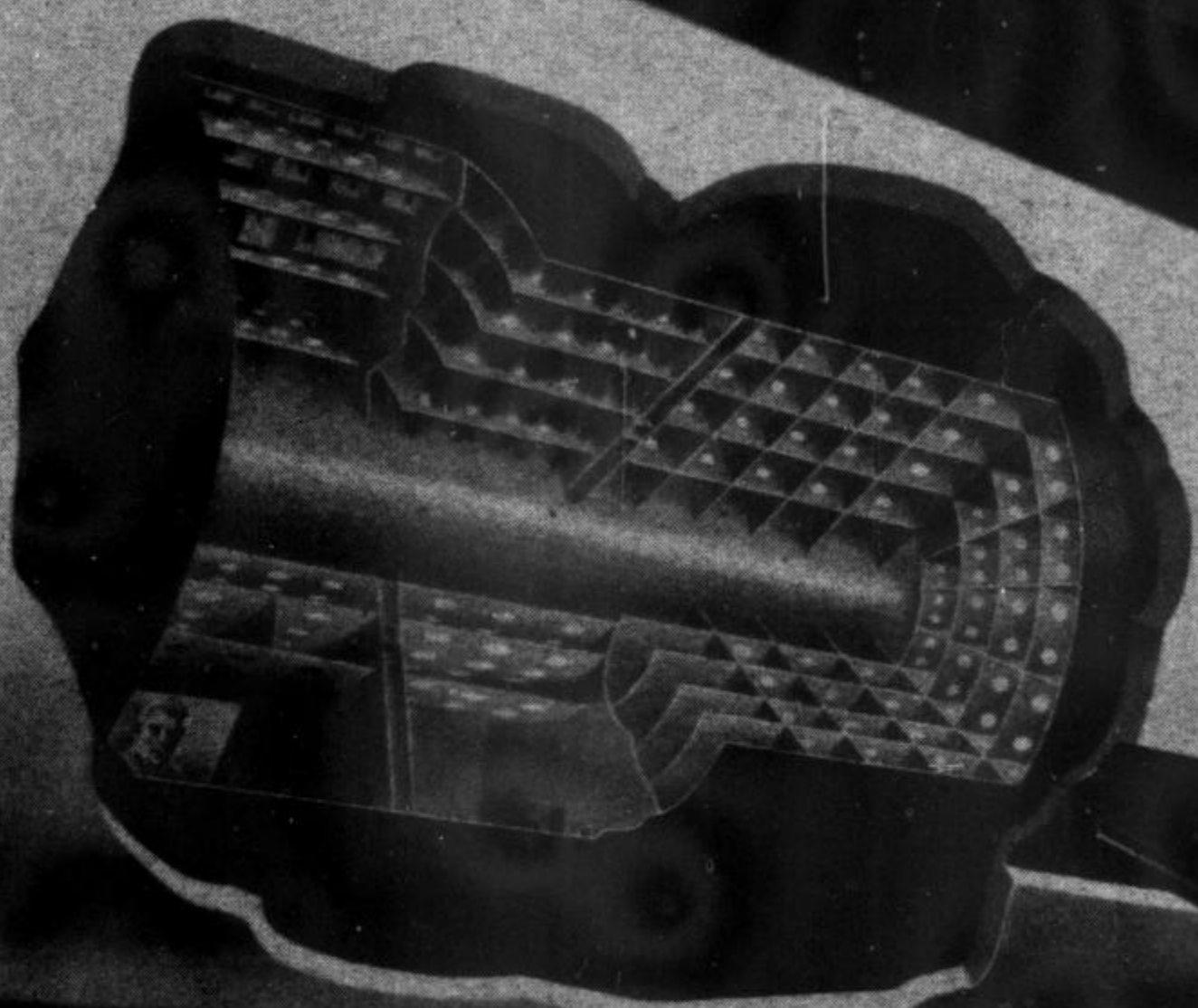
Transition forms between the loose colony and the deep space variety of Macro Life (which might be called Astro Life) are: the nuclear submarines, the Antarctic bases, the space simulators under study or development at several defense plants, the underground missile bases, and possible future underwater and underground bases which might be made more completely self sufficient for civil defense and research purposes.

Space simulators have been studied at Martin and General Electric and at other government and industrial laboratories. Work at General Electric on closed ecological systems has produced a water recycling system which was recently used in a test of a full week's duration.



It is now widely accepted that we must begin the task of learning how to live beyond the atmosphere rather than wait for the development of the big booster vehicles that will carry men to the moon. Waiting until transportation is available before starting studies of closed environments would cause unacceptable delays of several years. Thus, we can expect small simulated moon bases to be set up on earth during the next five years.

The crews of underground missile bases must receive the same elaborate protection as the missiles in their charge, if the bases are to have deterrent and retaliatory value. Protection against blast, heat, radiation, chemical, and biological weapons requires that the crews live in sealed underground quarters with adequate provi-



**Exploding
population and
exploding
scientific know-
how are the two
strongest forces
of our time**

Macro-life colony is shown in artist's conception. The giant space ship will be completely self sufficient and the inhabitants will be able to build duplicate colonies in order to relieve the pressure of its growing population.

sions for spending the duration of the all-out war in isolation.

Crews of nuclear submarines must also be prepared to spend considerable periods in complete isolation from the rest of mankind. There have already been cases where submarines remained submerged for as long as two months. Presumably, this time could be extended if necessary.

Interest is growing rapidly in various aspects of oceanographic research on a wide variety of problems. The House Science and Astronautics Committee has called for a vastly expanded national effort in oceanography to meet the Soviet submarine threat, and to exploit the untapped resources of the sea. A need has been identified for "open ocean manned research plat-

forms" which are stable and can remain in place so that time studies can be made. Considerable interest has developed in new types of research submarines and advanced underwater vehicles.

A possible version of the underwater base could be somewhat similar in construction to the space simulator. That is, it might be a pressurized sphere or cylinder some thirty or forty feet in diameter. The structure could be made almost entirely of transparent plastic for maximum visibility, or of steel with numerous windows. It would be desirable to have a large opening in the bottom to permit entrance and exit of laboratory personnel using Scuba, and possibly of tame dolphins as well!

(continued on page 48)

thermonuclear exhaust products from the energy release of a fusion chain reaction, such as that which occurs in super novas.

Admittedly, these systems are sheer speculation as of today. The problems to be conquered during their development will be imposing, but research efforts will continue because the potential thermonuclear performance range fulfills the ultimate needs of manned planetary exploration.

Macro-Life *continued from page 17*

If the bottom of the sphere is to be open, then the inside pressure must equal the pressure of the water at the depth of the opening. A reasonable compromise might be about fifty feet from the opening to the water surface. This would mean an internal pressure of twenty-five psi and a differential pressure at the top of about fifteen psi.

The sphere would be divided into compartments according to functions, and would contain living quarters, laboratories, dining and recreation areas, etc. Hydroponic farms might be included if it was decided to operate the base as a closed and balanced ecological system.

Besides the scientific and military reasons for building underwater bases there is also to be considered the value of such a base for civil defense.

It is generally assumed that the population could be adequately protected during all-out war by providing them with temporary blast and fallout shelters. Presumably a family or larger group after spending perhaps a week in such a shelter would emerge and return to their normal pursuits so rudely interrupted by the war. Unfortunately this common picture is far from the truth. If an all out nuclear war should be fought in say 1970, the survivors would emerge from their shelters to find themselves on an alien planet almost as inhospitable as the moon and perhaps even more inimical to life than Mars.

During the short period of nuclear devastation, most of the above

Many other advanced propulsion variations have been mentioned from time to time. Some have points of merit; all present serious development difficulties.

For example, the "Fizzler" would be a nuclear rocket engine that resembles an end-burning solid rocket by using a receding core which is controlled critically at the receding end. Then, the hybrid reactor with a solid plus gas core would attempt to in-

crease the power of a solid core system by adding U235 to the propellant gas. Finally, the photon rocket would utilize a highly efficient light source to obtain thrust from the momentum of corpuscular light particles.

In any event, we can expect at least one of the advanced propulsion concepts to someday drive our vehicles out into the interplanetary deeps far beyond the boundaries where chemical rockets falter. ■ ■

ground structures in the country would have been destroyed by blast or fire. Fire storms would have swept the country unchecked and destroyed practically all vegetation. All unprotected animal life would die from acute anoxia brought on by the fire storm, if not killed more quickly by blast, heat, or nuclear radiation.

While the background radiation might fall below the danger point for acute radiation sickness in some areas in a few days or weeks it would represent a danger of chronic sickness for years. The danger of bone cancer, leukemia, etc. would be too great to permit a return to normal earth life for a very long time.

In fact, it would be necessary for the survivors to live and grow their food in sealed shelters just as though they were on the moon.

While it would not be practical to move the entire population of the U.S. underground in, say, the next ten years, it would be feasible to build temporary shelters which could house the population in the critical period during and following an attack. Also, a one year supply of food could be stored in the shelters and the necessary tools and equipment for building permanent shelters. In particular, large quantities of transparent plastic would be required for construction of airtight domes to cover living areas. Also, stores of seeds for all varieties of useful plants and trees would be essential.

Research should be intensified on

the problems of storing the fertilized eggs of fish and birds in suspended animation. We should also intensify our efforts toward learning how to raise the mammalian zygote artificially.

An important fraction of an adequate national civil defense program should be devoted to the construction of a number of "Noah's Arks" permanently staffed with volunteer colonies. These "Arks" unlike other civil defense shelters would be completely equipped for an indefinitely long existence in complete isolation from the rest of the world. They would be a close approximation of Macro Life with all the capabilities for independent existence, growth, and reproduction of a true life form.

The Arks could be constructed underground in natural caves or artificial excavations, underwater in fixed bases, or possibly in nuclear submarines. A large nuclear submarine adapted from a military vehicle or constructed specifically for this purpose, could become almost as good an example of Macro Life as the extraterrestrial colony although it would be dependent on a supply of nuclear energy rather than sunlight.

The "Ark" should have a population of several thousand people plus the necessary plants and animals to provide a completely adequate and balanced diet. The underground colony should obtain energy for growing food, powering its tools, etc., from sunlight conducted from the surface through optical systems, nuclear

reactors, or both. It should provide all the requirements for work, education, and recreation normally available on the surface.

There are several obvious sources for populating these underground civil defense laboratories. One source is the "fanatic" religious group of the type which has already tried to set up such colonies on its own initiative. Such groups should receive encouragement and help in setting up a really worthwhile experiment in civil defense and sociology rather than the ridicule and opposition to their halfway measures which has been typical to date.

Another and probably better source would be a government sponsored university for qualified students who could not otherwise attend college. The experiment would be more useful if a rather large percentage of the students were married couples. In addition, it would be desirable to select the faculty primarily from those who were not only married and had children but who both had at least one skill essential to the health of the colony. (For example, the wife of the college professor might herself be a teacher either in college, high school or grammar school.)

Subterranean or submarine Macro Life could make two essential contributions to a realistic civil defense effort. It could provide insurance that at least a small nucleus of life and western civilization would survive and be prepared to begin the reconstruction of the country and it would provide a pattern for the survival of the rest of the population. Mere survival of human beings is not enough, any more than survival of certain specialized body cells after an accident is sufficient to insure survival of a human being. All the vital organs must survive as well as major fractions of less vital parts such as skin, bone, etc.

Modern society has moved too far along the path of evolution to expect its survival after a major cataclysm if only unorganized humans are protected. Machines, plants, animals, raw materials, and particularly knowledge



SPACE QUIZ

Assume you're a future college student majoring in "Spaceology". You're taking your final exam. You'll get your degree only if you answer 13 out of the 16 questions below, all of whose answers you read in this issue of SPACE WORLD.

1. **THE 6-ENGINE SOVIET BOOSTER WHICH ORBITED GAGARIN'S SPACESHIP IS RATED AT . . .**
 - a. 20,000,000 horsepower
 - b. 200,000,000 horsepower
 - c. 2,000,000 horsepower
2. **IN THE X-15, JOE WALKER ALMOST PASSED HYPERSONIC SPEED (5 TIMES THE SPEED OF SOUND) BY GOING . . .**
 - a. 3107 mph
 - b. 3307 mph
 - c. 3207 mph
3. **IF YOU WERE STANDING ON THE SURFACE OF THE MOON, THE HORIZON WOULD BE . . .**
 - a. 4 miles distant
 - b. 2 miles distant
 - c. 3 miles distant
4. **LONG-RANGE SIGNALS CAN BE MADE ON THE MOON BY . . .**
 - a. Rifle shots
 - b. Radio
 - c. Smoke signals
5. **IN ELECTRIC PROPULSION CONCEPTS, THE "PLASMA JET" UTILIZES . . .**
 - a. Vaporized blood plasma
 - b. Charged plastic particles
 - c. Ionized gas
6. **THE KEYNOTE OF "ION DRIVE" PROPULSION IS TO USE AN EXHAUST OF . . .**
 - a. Ions heavier than hydrogen protons
 - b. Super-speed mesons
 - c. Electrons plus positrons
7. **IN THE "NUCLEAR PULSE JET", ROCKET BLASTS ARE FORMED BY . . .**
 - a. Bursts of fission energy
 - b. Atomic bomb detonations
 - c. A series of nuclear chain reactions
8. **SINCE THE MOON'S GRAVITY IS 1/6 THAT OF EARTH, THE LUNAR ESCAPE VELOCITY IS . . .**
 - a. 1/6 of earth's
 - b. 1/5 of earth's
 - c. 1/7 of earth's
9. **THE TERM "TERRELA", COINED BY MARTIN FOR ITS LUNAR SIMULATOR, MEANS . . .**
 - a. Little world
 - b. Earthly site
 - c. Terrestrial model
10. **ALGAE, WHICH RELEASE OXYGEN, ARE MICROSCOPIC PLANTS FOUND IN . . .**
 - a. Soil
 - b. Water
 - c. Air
11. **NASA ESTIMATES EACH SATURN FIRING WILL COST APPROXIMATELY . . .**
 - a. \$20,000,000
 - b. \$2,000,000
 - c. \$200,000,000
12. **THE LETTERS "PSI", IN SEALED CHAMBERS, REFERS TO AIR AND MEANS . . .**
 - a. Positive static ions
 - b. Periodic synergic inertia
 - c. Pounds per square inch
13. **CAPE CANAVERAL IS . . .**
 - a. A rocket manufacturing center
 - b. A USAF base
 - c. A missile launching center
14. **HOW MANY REPORTERS CAME TO COVER THE MANNED REDSTONE LAUNCHING?**
 - a. 250
 - b. 500
 - c. More than 600
15. **WOOMERA IS THE NAME OF . . .**
 - a. The British missile range
 - b. An Australian aborigine
 - c. A solid-fuel military rocket
16. **TO GET A MAN TO THE MOON WILL COST . . .**
 - a. 20 billion dollars
 - b. 9 billion dollars
 - c. 40 billion dollars

Answers to Space Quiz on Page 62

must also be protected through the acute attack phase and for many years afterward. Each Macro Life unit should have as a part of its memory the Library of Congress reduced to microfilm. It should have supplies of all the basic tools and machines, and should have representatives of all the major professions, science and engineering specialties, and trades. Some of this could be handled by duplication of function since an expert in one field could also be a master of a second and work it as a hobby. A professor of history, for example, might enjoy gardening and make an important contribution to the colony food supply.

Besides the primary functions of insuring the survival of a viable nucleus of society and in serving as a model for the survival of a much larger fraction of society, subterranean or submarine Macro Life would serve as a model of an extraterrestrial colony, would be an excellent laboratory for much needed sociological and political research, and fill an oft stated need for federal aid to higher education.

In summary, it is proposed that in recognizing civil defense as a major

aspect of the modern defense problem, that the government extend its policy of maintaining service academies into this new cold and hot war discipline. These civil defense academies (and there should be more than one) should be established underwater or underground in isolated areas far removed from military targets. They should have the capability for operating as closed and balanced ecological systems although they would not necessarily maintain this discipline continuously. There would be no need to exclude normal luxury items during peacetime just so the capability for providing all essentials from within the colony itself was always held on "15 minute alert".

These civil defense forms of Macro Life could have all the major attributes of life exhibited by Astro Life itself except possibly that of motion, and even this might be provided in the submarine form. However, they would not have the independence of Macro Life and would always be under the control of the parent state. While they would have the inherent capability for growth and reproduction they would not normally be allowed to exercise these functions ex-

cept in the unlikely event of war.

The resemblance of an extraterrestrial colony to a living being might have some academic interest whether or not such colonies ever become a reality. However, our history and our present behavior both point to the early establishment of such colonies.

The reasons for establishing space colonies go back to the two basic cosmic reactions which have apparently passed their critical points and are now in the detonation phase. These are the detonation of life or "biodetonation" in the form of uncontrolled human population growth, and "sophidetonation" or the explosion of knowledge. The latter term, derived from the Greek "sophia" for skill or knowledge rather than "sophos" — wise, represents an even greater threat to society than the population explosion, and is increasing at a much greater rate. This is fairly obvious since the expanding population is putting an increasing percentage of its effort into the acquisition of knowledge and is developing greater skill in this acquisition. Society is also just beginning to realize that the statement "knowledge is power" is literally true and that the "armament race" is just one aspect of the "knowledge race".

Population pressure and the drive for new knowledge are two of the primary reasons for space bases and colonies. A third reason, a consequence of the explosion of knowledge is the military need to avoid obsolescence of retaliatory armaments and to push constantly for decreased base vulnerability and increased warning time.

The above reasons can be considered good reasons only if space bases can be constructed at reasonable cost. But sophidetonation and the corollary increase in technological skill can be expected to reduce costs at a very rapid rate. Increase in propulsion system performance, increase in space vehicle size, and recoverability will reduce space transportation costs to the level of present



Asteroid Colony. Population explosion on earth may some day be eased by building colonies in giant, hollow asteroids where people could make their homes.

intercontinental air travel costs in twenty to thirty years. This may seem more plausible if we note that the total velocity change required for a round trip to the antipodes by ballistic rocket is 52,000 feet per second while the total for a round trip to the surface of the moon is only 53,000 feet per second. While many technical problems remain to be solved and while I do not mean to minimize the difficulty of manned space flights, the energy requirements have been greatly exaggerated. Theoretically, an airplane could accelerate to orbital speed and altitude while burning less fuel than is now required for a jet airplane of the same weight and payload to fly halfway around the earth!

Early development work has already started on systems which should reduce the cost per pound transported to orbit to less than one hundred dollars by 1970. With systems which look reasonable on paper this cost could be down to ten dollars per pound by 1975 and one dollar or less by 1980.

Now on the other side of the coin is the cost of the payload itself. If the payload is a rocket propellant for a deep space vehicle, it may cost less than a dollar per pound, thus there will be incentive to reduce transportation costs to this level. However, most space payloads will have a much higher value approaching several thousand dollars per pound for complex electronic hardware.

The payload usually considered to be of the highest value is the human pilot and crew. However, they are not necessarily of any greater economic value to society than the electronic equipment.

Suppose that a space pilot makes an average of \$25,000 per year for forty years. Then one convenient measure of his value to society would be the product of these two numbers—one million dollars. If he happens to weigh 166 pounds, he is worth about \$6,000.00 per pound. While this is a high price, it is of the same

RUSSIAN REPORT

Optimism in Moscow

Since Yuri Gagarin's epochal space flight, Russian scientists, technicians and writers seem to have lost any doubt at all that manned exploration will spread throughout the solar system, and eventually leap beyond into interstellar reaches.

The popular Russian press and the more scholarly journals are full of aggressive, optimistic articles about man's coming conquest of space. Typical is this report by Professor S. Sonnshein, noted Russian physicist, that appeared in the *Literaturnaya Gazeta*:

"Science, as it stands today, gives ample room for the hope that a breakthrough will enable voyages beyond the solar system. . . . If we are to cover the staggering distances separating us from other galaxies, and to overcome the conflict between the life-span of man and the duration of an interstellar voyage, we have to make the speed of the star ship comparable with that of light. This is within the reach of the photon rocket, also called the quantum rocket.

"This type of propulsion system operates on a simple principle: light particles, or photons, recoil from a solar sail in a narrow beam to produce thrust. However, a practical realization of such a device for using photon momentum for propulsion is extremely difficult. For one thing, the requisite beam of photons must be either produced or somehow picked up. Secondly, the solar sail must have a very high reflectance and be transparent to photons or it would melt. Above all, we still have to learn how to control the conversion of matter and energy in conformity with Einstein's relativity theory. As soon as we have learned these things, however, unprecedented horizons will

open before us for space propulsion and travel to distant worlds."

To the Moon

An article in *Komsomolskaya Pravda*, deals confidently with the moon: "The first thing to be built on the moon will be an observatory. The point is that it has no atmosphere to interfere with optical observations as is the case on earth. The ambition of the Soviet scientists is to turn the moon into a mammoth scientific center for the entire solar system. They will train their moon-mounted telescopes far deeper into the universe to peep into the secrets of star formation, cataclysmic processes whose echoes are picked up by the sensitive 'ears' of radio telescopes.

"How soon will all this happen? Is it not too far in the remote future? No, it is not! A few decades will be quite enough for man to accomplish this task. Recall what our country was like 44 years ago. Nobody will dare to say that a nation which has broken away from poverty and illiteracy and into outer space within 4 decades will not achieve its goal."

Unlimited Horizons

And in the same aggressive vein, mathematician V. Krasovsky writes in *Izvestia*: "Today, our Soviet scientists are outpacing the science-fiction writers. We are diverting rivers, leaping beyond the earth and taming the powerful fusion reactions of the sun. Nature is loath to confide its secrets in us. But we wrest these secrets from her. We are learning more and more every day. Unlimited horizons are opening before us. Thousands of roads are leading to the summit of knowledge, and Soviet scientists are marching on every one of them."

order of cost as some of our electronic equipment and also some of the high priced drugs.

Applying this yardstick to Astro Life we may note that the human cells are not of uniquely high cost and cannot be distinguished in this way from some other vital organs or parts. However, the combined value of a colony of 10,000 humans in an Astro being would have an economic value of perhaps ten billion dollars

and might exceed the entire remaining cost of the vehicle.

Thus we can expect space transportation costs which now run close to initial high priced payload costs per pound, to drop down to values approximating initial propellant costs within the next twenty to thirty years. When this cost reduction has occurred it will be no more expensive for a family to emigrate to Mars or the asteroid belt than it now is to

emigrate to Australia. By this time, also, sophidetonation will have provided us with all the knowledge necessary to live comfortably almost anywhere in the solar system, and the emergence of true Astro Life will be technically and economically feasible.

Social and Political Significance

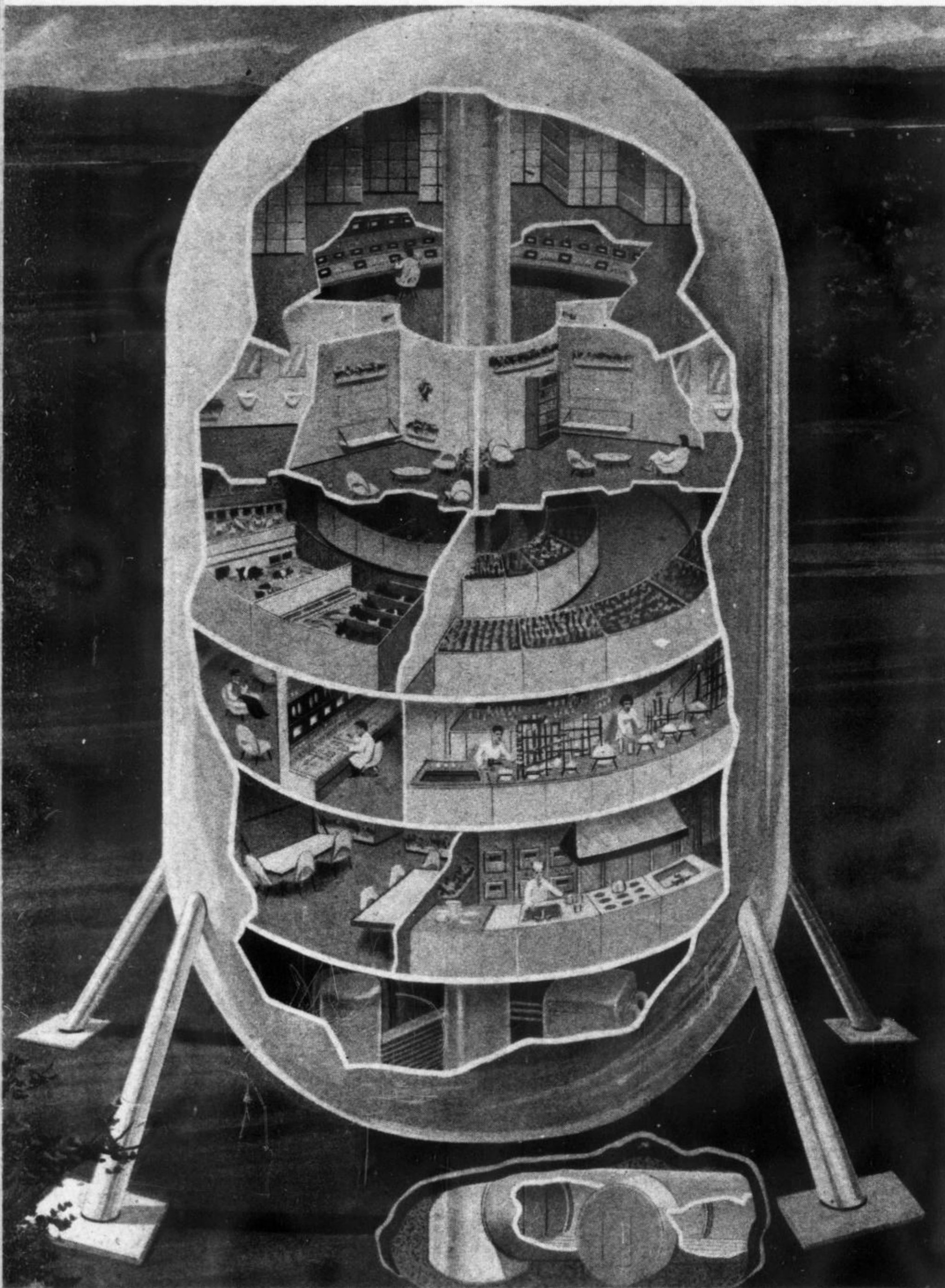
The social and political implications of such basic alterations in our society as have been pictured here could not fail to be of major significance. Whole books could be written describing the nature of future societies resulting from the trends described earlier. Orwell's "1984" and Huxley's "Brave New World" are good examples of what might be done in this field. However, at this time we intend only to make a preliminary survey indicating some of the most basic problems which can be expected to arise with the birth of Macro Life in space and on the earth.

Some of the preliminary forms of Macro Life such as the subterranean and submarine civil defense colonies could appear in the next five to ten years. Initial space colonies may appear in ten to twenty years. True Astro Life will probably appear in twenty to forty years.

During this period life on earth will take on more and more of the characteristics of the space colony and Macro Life, whether or not the fear of nuclear destruction drives large segments of the population underground. The population density of the whole earth will be at the maximum level represented by the efficient space colony in no more than a few hundred years and possibly less than one hundred.

There is a rather strong implication in the preceding sections that the very high density, highly integrated, and efficient society of the future must necessarily have a tyrannical rather than democratic form of government.

Macro Life exemplifies the ultimate society. But we recognize this as a vehicle and a vehicle implies a captain with absolute authority over passengers and crew. It is generally.



Cell Colony. Artist's conception shows proposed design for a completely self-sufficient colony that could be built and staffed to test theories of Macro-Living.

An announcement from Simon and Schuster about

THE SCIENTIFIC AMERICAN BOOK OF PROJECTS FOR THE AMATEUR SCIENTIST

agreed that the close knit, interdependent society of a ship or a military base could not function effectively with any form of government but a tyranny in the original sense of the word. A democratic government of a ship or a space colony would presumably lead to indecisiveness, confusion, and unacceptable hazard.

However, this is not necessarily the case. We must become more efficient in our social, political, and technological operations as our living space on earth implodes around us and we attempt the colonization of interplanetary space. But increased efficiency does not automatically mean a necessity for relinquishing our basic freedoms. We will lose some of the freedoms we now enjoy, we could lose all of them, but we need not lose our most highly prized freedoms, if we make an effort to retain them.

Our great danger is that we will fail to recognize present trends toward tyranny and will be only half conscious of the slow erosion of our most precious freedoms. The great pressures forcing our society into a more dense and more rigid ultimate form raise doubts as to the ability of the average man to govern himself, and give those seeking power the opportunity to steal a little more from the sleeping public.

In order to have some hope of retaining any of our freedoms, we must do several things and do them soon. We must first of all define and elucidate what it is we want to preserve. We must compare our desires with present realities and future problems. We must order our desires according to preference. We must observe and analyze possible conflicts between freedoms. And we must determine the cost of preserving the most prized freedoms in terms of material welfare, danger to the survival of the race, and loss of conflicting freedoms.

No one would claim that our existing society is perfect or that ours is the best possible form of government in all respects. In evaluating our present treasure of freedom and investigating possible dangers we should not ignore the possibility for

WE have just published the first book—a big one of 587 pages, bound in full cloth for hard wear—compiled from C. L. Stong's "Amateur Scientist" Department in *Scientific American*.

Even the most devoted veteran reader of this magazine will be struck by the richness of the contents. They range over every area of 20th century science from Astronomy (*make your own electronic star-twinkle suppressor*) and Archaeology to Nuclear Physics (*out of a 2 ounce whiskey glass, a cloud chamber*) and Mathematical Machines (*how to construct a puzzle-solving machine that cries when it's in trouble*).

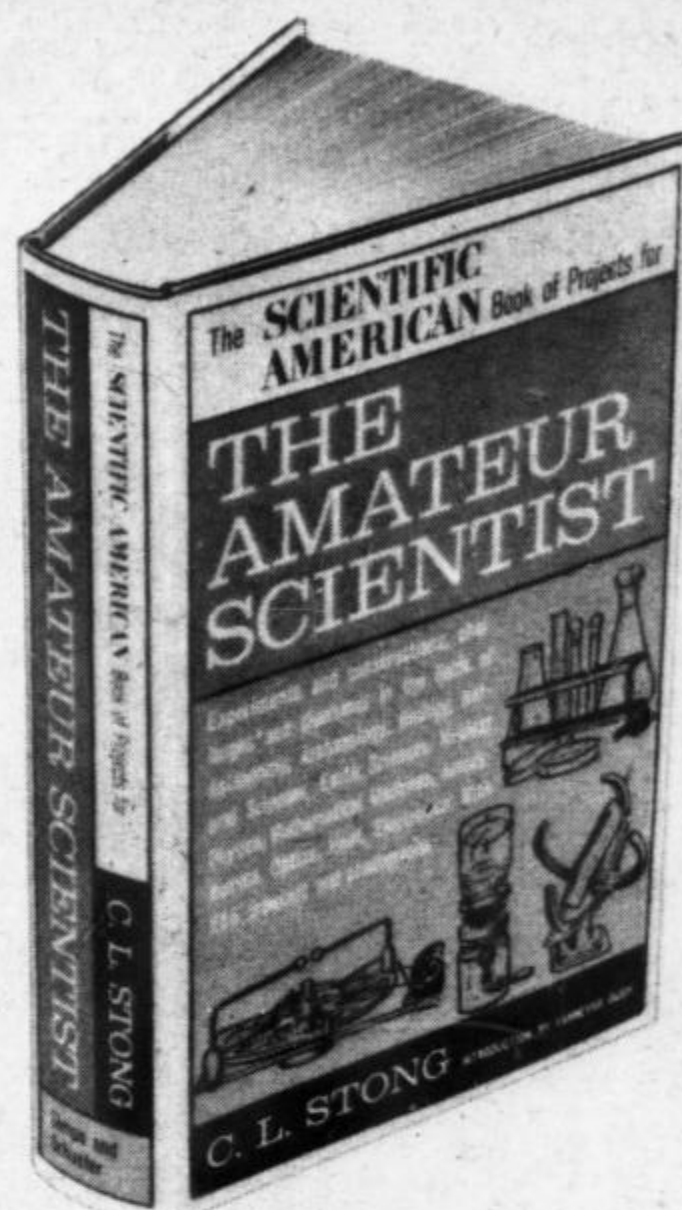
From "Miracle Drugs" to Rocketry—587 pages of experiments

The book contains the most exciting experiments and constructions presented to date—revised, expanded, comprehensively indexed, furnished with references for further reading, and prefaced with an introduction by Vannevar Bush. Roger Hayward's inimitable drawings, plus the photographs, add up to 256 illustrations to help the experimenter. Price is \$5.95.

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INDEXED BY P.A.L.

**There have been many
rumors recently about
Russian cosmonauts killed
in spaceflight. Here
are the facts . . .**

by WILLY LEY



Russian Space Expert. Dr. Leonid Sedov told American reporters he knew of no Soviet space deaths.

MURDER

THE SEED FOR THIS ARTICLE was planted a few weeks ago when a friend of mine asked whether I had seen the current (June) issue of *True* magazine. When I said "no" he explained that the magazine carried an article on the Russian Man-In-Space program.

"Wait a moment," I said. "I'd like to make a guess about its theme. At *True* they always believe either too much or not enough. That's how they once built up the Flying Saucer craze on the one hand, while on the other hand they informed the American public that the Russian space probe *Metchta* or Lunik I was merely a big 'Red lie'. What is it now—Yuri Gagarin didn't make his flight?"

"Not that," my friend replied. "The piece is all about the astronauts they *murdered*."

"Murdered?" I asked. "What happened, or rather, what is supposed to have happened? Did they shoot astronauts who had mutinied?"

"No, no, no. *True* apparently maintains that an astronaut who loses his life because something goes wrong with the spaceflight has been murdered. But terminology aside, have you ever heard stories about that?"

I readily admitted that I had heard such rumors—who hasn't?—and that I would not be surprised if the Russians did lose a man or two. Accidents do happen. But so far there has been no official news from Russia. Considering their methods of censorship and controlled news, how could anybody know? But my friend insisted—as have several other people since—that he wanted to know my personal opinion.

Here it is:

The *True* article (which I later read) makes a number of claims which are presented in a manner reminiscent of the panting of a large mammal after a three-mile chase. The incidents are not even presented in chronological order. Re-assembled in proper sequence and without "dramatization" the claims run as follows:

During the years 1957 to 1959 the Russians lost three men due to failures of non-orbiting rockets which were near-vertical high-altitude shots. The sole foundation for this claim is a report from the Italian *Continetale* news agency which is said to specialize in news from and about Russia. (A West German newsman I know, however, referred to this agency as a *Fama-fabrik*, which can be best translated as "rumor factory".)

At any event it was stated that, in 1957, a Russian named Alexis Ladovsky went to an altitude of 200 miles in a rocket, at which point all communication stopped. In February 1958 one Serenty Schiborin is supposed to have suffered the same fate. About a year later, namely in January 1959, one Andrei Mitkov was allegedly killed because the rocket he was riding

(continued on page 14)

R IN OUTER SPACE



No less than 8 deaths have been unofficially tallied

exploded shortly after lift-off.

Experiments acknowledged by the Soviets for the time interval in question include, in addition to Sputniks I, II and III, a number of vertical shots carrying animals. For example, for May 1957 (according to an article in *Pravda* of March 27, 1958) the Russians claim a shot to 131 miles altitude, carrying several dogs in a capsule which had a total weight of 4,841 pounds. For August 1958 they claim an altitude of 281 miles with a single stage rocket carrying a payload of 3726 pounds. In both cases the capsules were heavy and presumably large enough so that they could have carried a man.

It is, therefore, quite possible that they made an attempt at what is now called a sub-orbital shot with a man. It is equally possible that such an experimental shot failed. And, of course, if it did not go into orbit and swing over our hemisphere we could not have discovered it with our tracking systems.

Where I differ from other people who also concede the possibility of such accidental deaths is that I am not convinced that the Russians would have kept total silence. A state funeral with banners, parades, speeches and editorials extolling the heroism of the Soviet aviators sounds far more likely.

And if the ruling circles of the Soviet Union might have thought it detrimental to their prestige to disclose

such facts at the time, I tend to believe that this would have been changed by Yuri Gagarin's successful flight.

After success, they could easily have staged a fine state funeral for "Gagarin's unsuccessful predecessors who died in the line of duty".

I cannot help quoting, at this point, a breakfast conversation I had with my wife. When the *New York Times* published a photograph of a bronze bust of Gagarin only three or four days after the flight, my wife remarked that it takes weeks to make a bronze bust so that it must have existed before Gagarin took off. Whereupon I answered that the same bronze bust could have been a monument if something had gone wrong; it would have been useful regardless of the outcome of the flight.

My supposition is that the Russian propagandists could have shrewdly calculated that the death of a brave man in hostile space might arouse the world's admiration, despite failure of the flight.

After firing a number of ballistic missiles into a pre-selected impact area in the Pacific Ocean in January 1960, over a range stated to be 7700+ miles, Sputnik IV was put into orbit on May 15, 1960. According to Russian releases this satellite had a total weight of 10,009 pounds, including 3250 pounds of instrumentation and a "self-sustaining biological cabin" weighing 5512 pounds. This satellite, as well as the



Welcoming Committee. Jubilant crowds gather in Moscow's Red Square to welcome Yuri Gagarin, Soviet spaceman and the first man to return from outer space alive. Some people believe that more Russian spacemen tried and were killed.

for Soviet space science

later Russian satellites, was undoubtedly fired using the booster tested in January with greater thrust than ever before.

Sputnik IV was a re-entry test vehicle, both according to Russian claims and by performance. Four days after putting the satellite into orbit the Russians sent a radio command to the retro rockets to slow the ship down and put it into the re-entry arc leading back into the atmosphere.

But the retro rockets, firing in the wrong direction, accelerated the satellite, pushing it into a larger and higher orbit. Almost simultaneously the satellite broke up into eight or more pieces, most of which are still in orbit. The Russians admitted that their experiment had not worked out as planned.

In the release made before the satellite malfunctioned, the Russians had stated that the biological capsule did not contain any animal life but only an instrumented dummy of a spaceman. At once a number of people guffawed, deciding then and there the "dummy" was a man. The article in *True* also takes this attitude, quoting the "beliefs" of "very responsible people" who, however, were not named.

Well, the very performance, such as it turned out to be, makes me feel convinced that there was no man in the cabin. If there had been an astronaut in the cabin, the firing of the retro rockets in an emergency would obviously have been his job. And he (the pun is unavoidable) couldn't have been such a dummy that he fired them without checking and double-checking his ship's position. After all, his life was at stake.

In a space capsule of sufficient size the presence of a man can very easily be the decisive factor for success, where mere equipment, mechanical or electrical, could spell failure because of one loose bolt or broken wire. Our own Mercury capsule can similarly be taken over by manual control of the pilot.

On August 19, 1960, followed Sputnik V with several dogs, rats and smaller life forms aboard. Like Sputnik IV it was a re-entry test vehicle but unlike Sputnik IV it worked. Sputnik V was successfully de-orbited 24 hours after firing, re-entered and landed safely in the general area in which it was supposed to land.

In this case, oddly enough, nobody ever claimed that there had been a man aboard, perhaps just because everything had gone well. But the reams of speculations we would have had to read if that ship had burned up!

Now we come to the case where it can be considered almost certain that something went wrong.



Protective Devices. Elaborate pressure suits are worn by Soviet animals and men as safeguard for their lives.

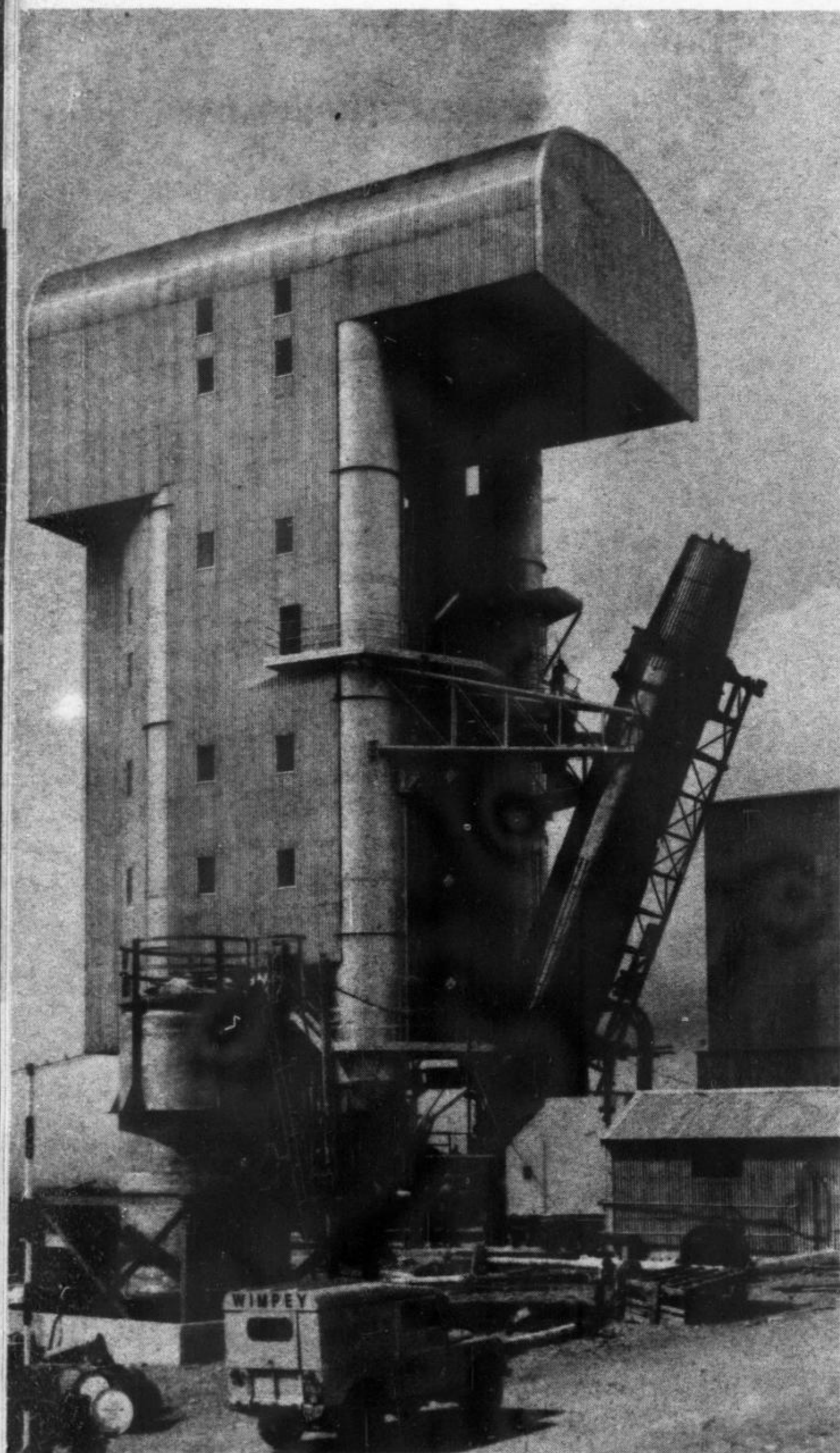
It might be called "the attempted shot of October 4, 1960." The date is important because it was on another October 4, in 1957, that Sputnik I went into orbit. Sputnik I had originally been planned for September 17, 1957 because that date was the centennial of the birth of Konstantin Eduardovitch Ziolkovsky, the Russian space travel prophet.

For reasons we don't know the Russians did not make that date. But to them the actual launching date of Sputnik I established a new anniversary in its own right . . . of the world's first satellite. In 1959 they fired "Cosmic Rocket III" or Lunik III, which took the first pictures of the far side of the moon, on October 4. By midsummer 1960 everybody began to wonder what they would do this time. (continued on page 63)

INDEXED BY P.A.L.

WOOMERA

A picture report on England's Missile Testing range

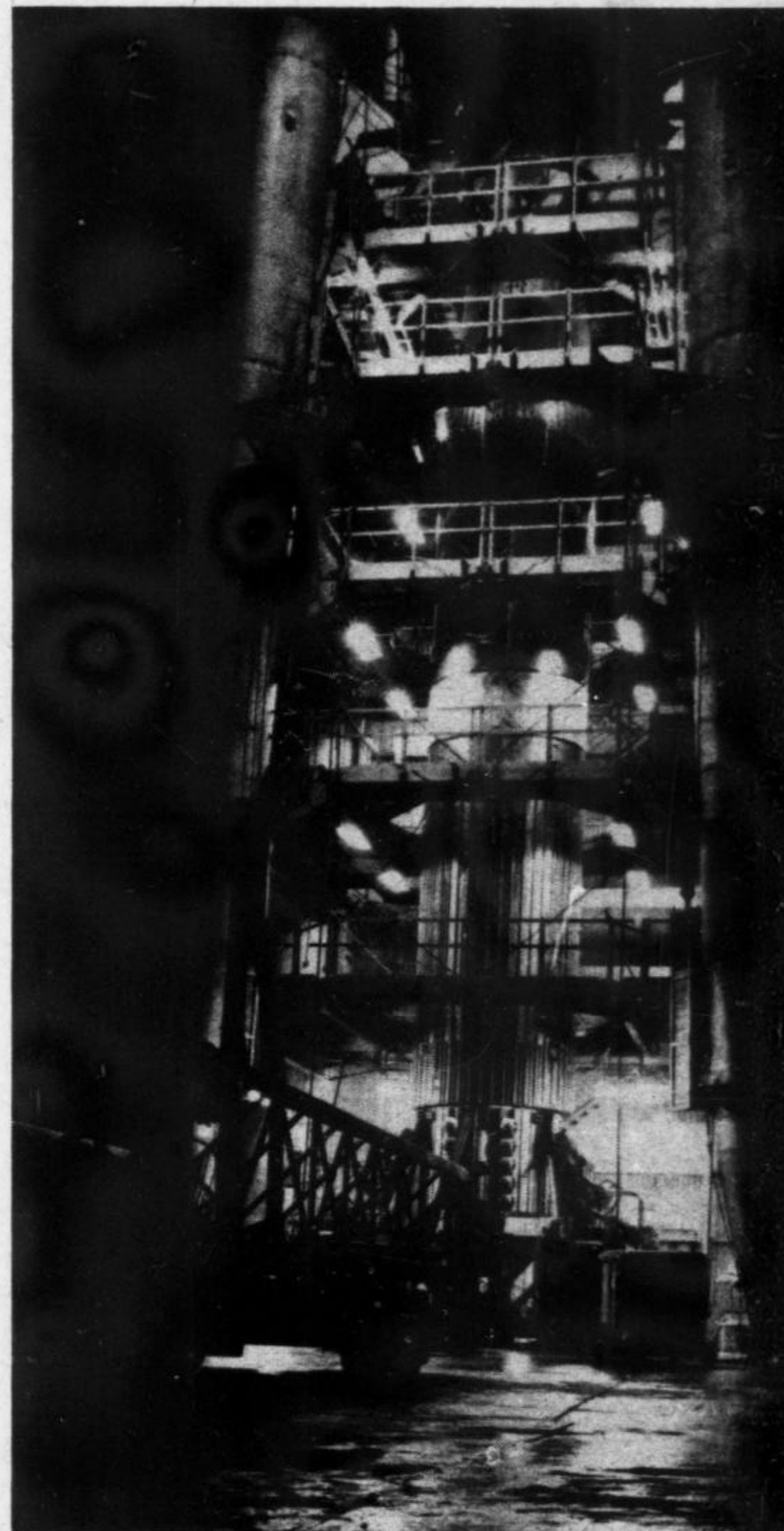
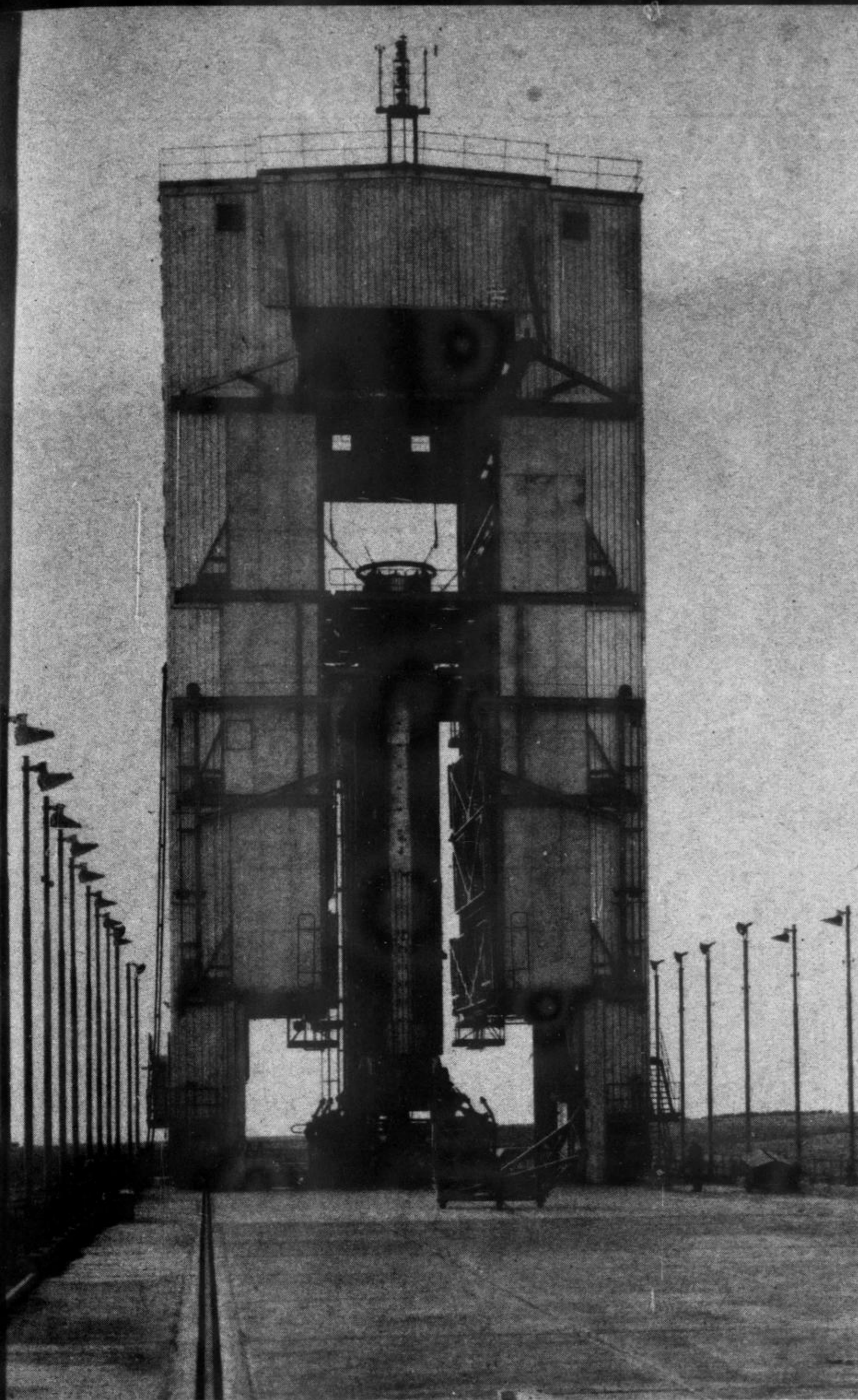


Blue Streak. This powerful 250,000-pound-thrust English rocket, shown here before a series of static engine tests, will be launched from a Woomera launch pad.

New Facilities. Picture, right, shows launching pad and rocket gantry now being built at Australian range.

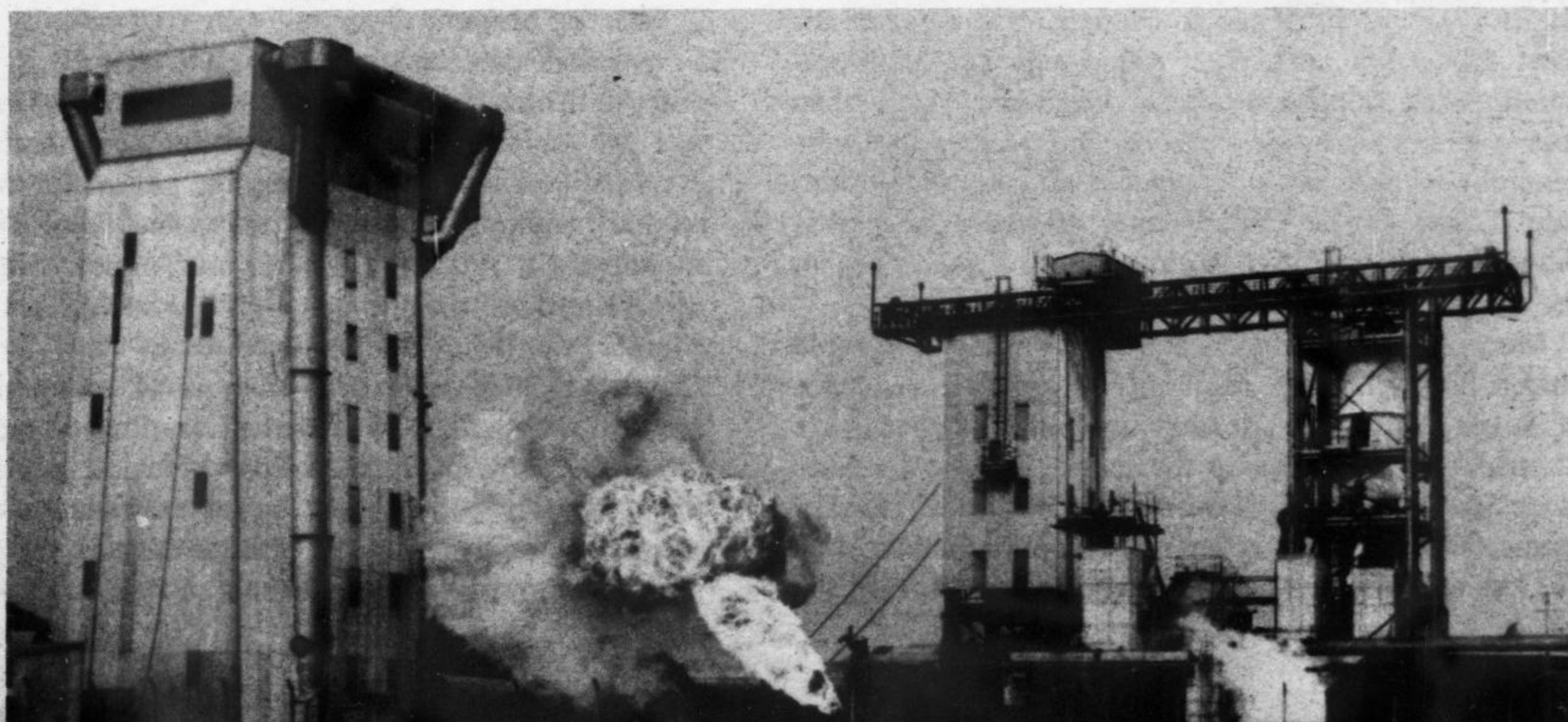
The British space effort will soon go into high-gear with the launching of the Blue Streak booster. A powerful, 250,000-pound thrust vehicle, the English rocket will be able to loft comparatively heavy payloads into earth orbit. Launching facilities for the Blue Streak and other British rockets are now being rushed to completion at the Woomera Missile Range in Australia. Here, in the empty deserts of north-eastern Australia, a huge complex of launching pads, blockhouses, testing stands, and control stations is being readied for test-launchings of the British rockets that are scheduled to begin late this year. Incorporating the latest advances in techniques and design, the Woomera installation is being designed to handle not only the Blue Streak booster, but also more powerful rockets that are now in the research and development stage. Its geographic location, far from any large population center, and adjacent to the open range of the Pacific Ocean, make Woomera an ideal missile range site. Here, on these pages, SPACE WORLD brings you a picture report on a new facility that will become an important part of the West's space effort.





Night View. British rocket, above, glows under lights during recent tests.

Test Facilities. Test stand, 1, is designed for complete checkout of Blue Streak rocket. Turbo-pumps, below, make spectacular display during a trial run.



INDEXED BY P.A.L.

Power for Interplanetary Travel



Lunar Colony. Manned bases on moon will be possible when advanced propulsion systems enable us to loft huge payloads to our satellite on relatively moderate cost-per-pound basis.

**New propulsion systems will
power future manned probes.**

by **MAX HUNTER**
and **EDWARD BONNETT**

Advanced propulsion beyond today's technology is the "key" that will open the frontier of space to manned exploration and "shrink" the enormous magnitude of the solar system to dimensions of reasonable cost and travel time.

Two fundamental, technical factors make space exploration much more costly than the conquest of earthly frontiers of the past two centuries. They are: 1) overcoming gravity; and 2) the need for guidance systems with a reaction time far superior to that of man.

Researchers are concentrating on developing propulsion systems of sufficient power to not only launch sizeable payloads but to reduce the degree of sophistication in the guidance, control and ecological systems. In preparing for manned space flight, scientists and engineers have already developed computer systems capable of guiding vehicles unerringly through the void of space. In addition, a spaceship will carry adequate shielding to protect the crew from cosmic radiation, space debris and radiation from vehicle power-sources if they are nuclear. It will also carry a packaged or replenishable (regenerative) earth-like atmosphere, a supply of life-sustaining nourishment and some form of relief for the astronaut's psychological needs.

These systems, plus the explorers, add up to a substantial payload weight which imposes severe requirements on the vehicle propulsion system.

In considering the state-of-the-art in space propulsion, two terms are of key importance. These are:

Specific impulse—this is a measure of the force (impulse) produced per weight of propellant expended, per unit of time.

Impulse-to-weight ratio—this is the thrust capability per pound of propulsion plant weight.



Lunar project. Electric arc propulsion systems, presently under development, will be able to send huge payloads to the moon.

Numerous advanced rocket power systems for deep-space penetration have been conceived, and some are under development. These varying systems differ in basic power source, in method for energy utilization, and in mission application. Studies indicate that to achieve major propulsion gains over the chemical systems of today the energy sources must be nuclear.

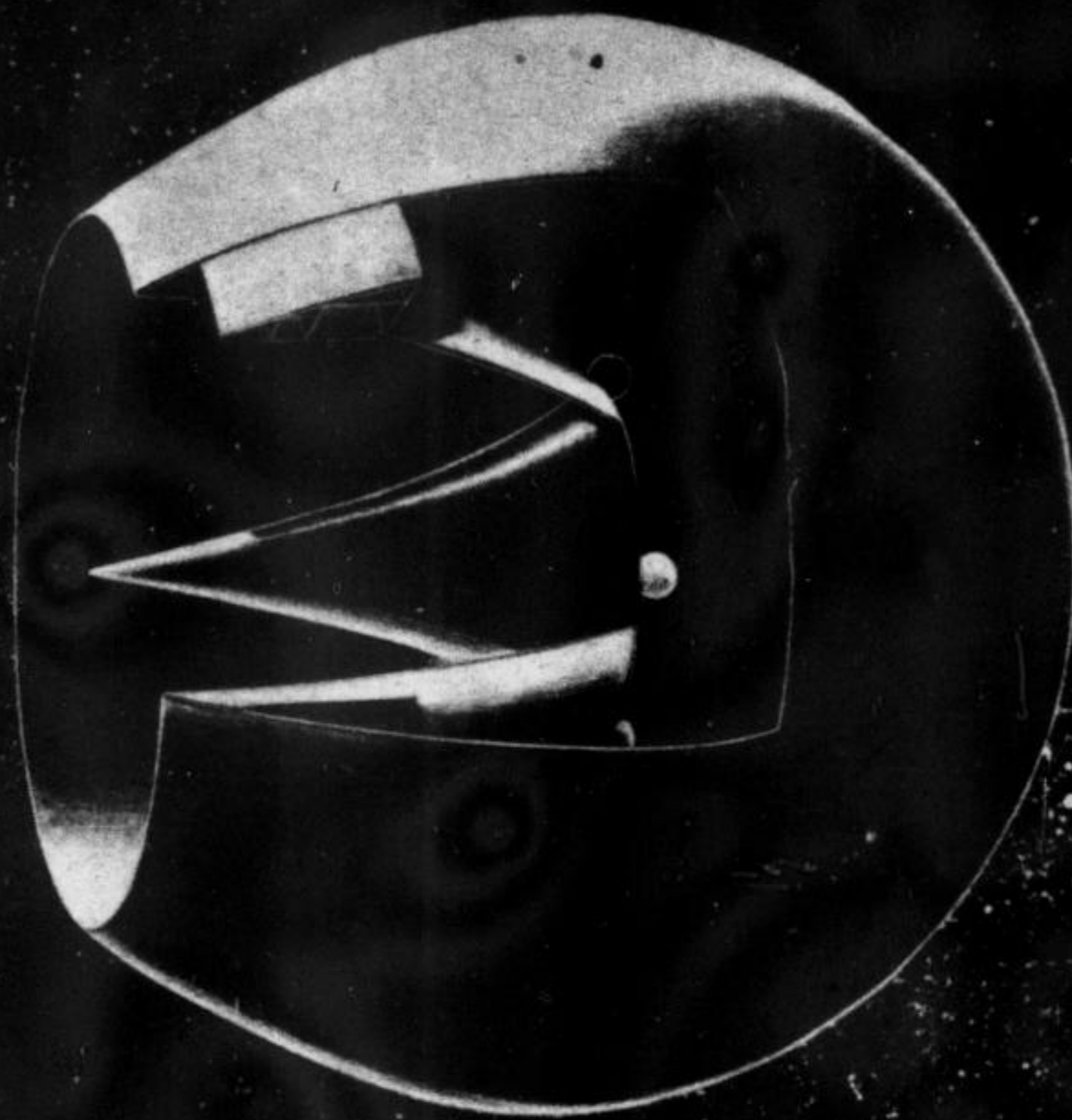
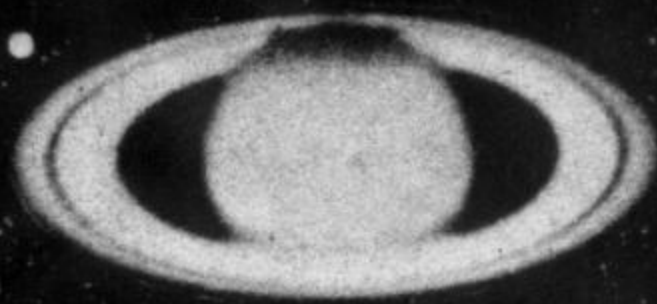
Both atomic fission and thermonuclear fusion processes are *promising*. At present, quite a few systems for utilizing fission energy are under study. Several may soon reach the hardware stage.

Solid-core systems (nuclear heat plus a gaseous exhaust) will permit fairly ambitious Lunar, Martian and Venusian missions but will lack the performance desired for sophisticated manned interplanetary travel of unlimited degree.

The next advance in nuclear-thrust production might be the liquid-core reactor. This may never achieve the hardware stage because its high-temperature performance range is bounded by the melting and boiling temperature of the reactor's uranium compounds. However, it could, if successful, offer a significant gain in propulsion power.

The typical liquid-core concept is a flow of hydrogen radially through a liquid uranium compound that is held against spinning container walls by centrifugal force. The hydrogen is thereby heated to a temperature near that of the liquid compound—approximately 7000° F.

A propulsion system with a still greater potential is the gaseous core reactor which operates in a hyper-temperature range beyond that of liquid-cores. Two



Saturn Probe. Missions into deep-space will be accomplished with advanced powerplants based on thermo-nuclear generators.

Ion, nuclear, arc jet and photon engines will

types of gas cores are currently being discussed. One of these depends upon centrifugal force for gaseous uranium containment while the other uses magnetic forces to confine an ionized uranium plasma.

Basic problems in the development of gaseous core systems are the magnitude of gas pressure and magnetic field strength required which must be designed down to small size and weight, allow for costly uranium losses and achieve operational stability of the gas-confinement technique. Both theoretical and experimental programs are under way at this time to determine feasibility of gaseous core propulsion systems in the hopes of finding breakthroughs.

Another major class of advanced propulsion systems will be designed to convert thermal energy from a nuclear source into electrical energy, which is then applied to acceleration or generation of high-temperature plasmas composed of ionized particles. Work is under way to develop efficient, reliable electrical thrusts from such super-speed ionic exhaust products. Experiments with such devices are relatively simple to carry out in the laboratory because of the small size and low cost of the required equipment. This apparently is a major reason why these systems are advancing rapidly

to the flight-test stage.

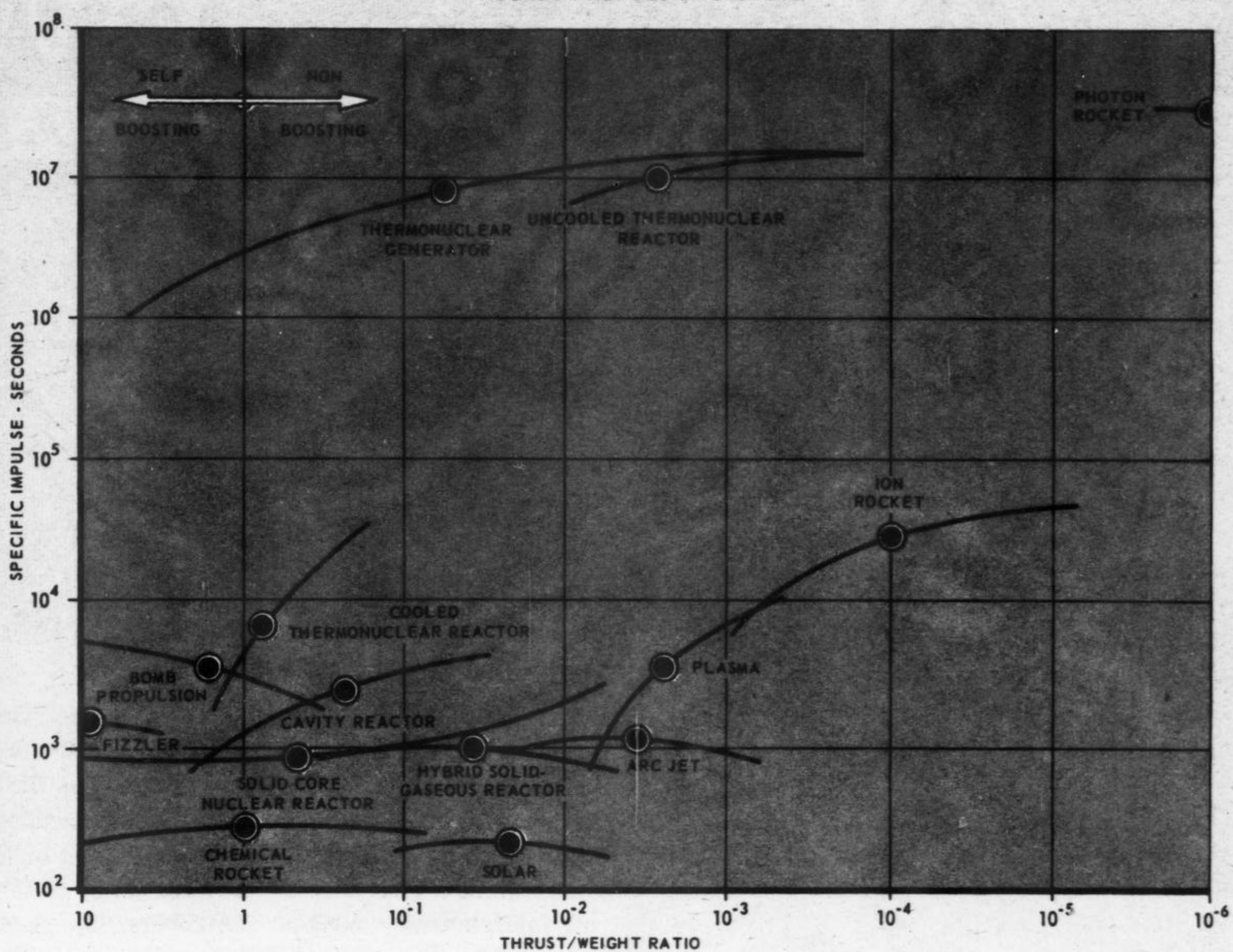
P rime systems under development for generating electrical power involve nuclear reactors used in conjunction with conventional turbogenerators. Other programs are also under way to utilize thermionic (direct heat-to-electricity) systems in conjunction with reactors. There are many variations of these basic techniques.

The arc jet system. In this device, the propellant gas is heated as it flows through an electrical arc between two electrodes. The gases then pass into a settling chamber where temperature equilibrium occurs before this reaction mass exits through a conventional nozzle to produce the rocket's thrust.

This system is handicapped by the temperature limitations of its materials, much as the solid-core nuclear device. The other drawbacks affecting the arc jet's operating range are energy losses to the device's walls and inefficiencies in the exhaust nozzle.

The plasma jet. This can give a somewhat higher performance than the arc jet. As in all types of these electric devices, the propellant is a partially or fully ionized gas, with negative electron and positive ion densities maintained essentially equal to each other so

THEORETICAL PERFORMANCE OF ADVANCED ROCKET PROPULSION SYSTEMS



will surpass chemical rockets

there is no net space charge of either sign in the exhaust mass. The plasma is formed by passing a high current through the propellant gas, which is then ionized by collisions among its nuclei. An electromagnetic field is supplied to accelerate the electrical-conducting plasma particles to high velocities.

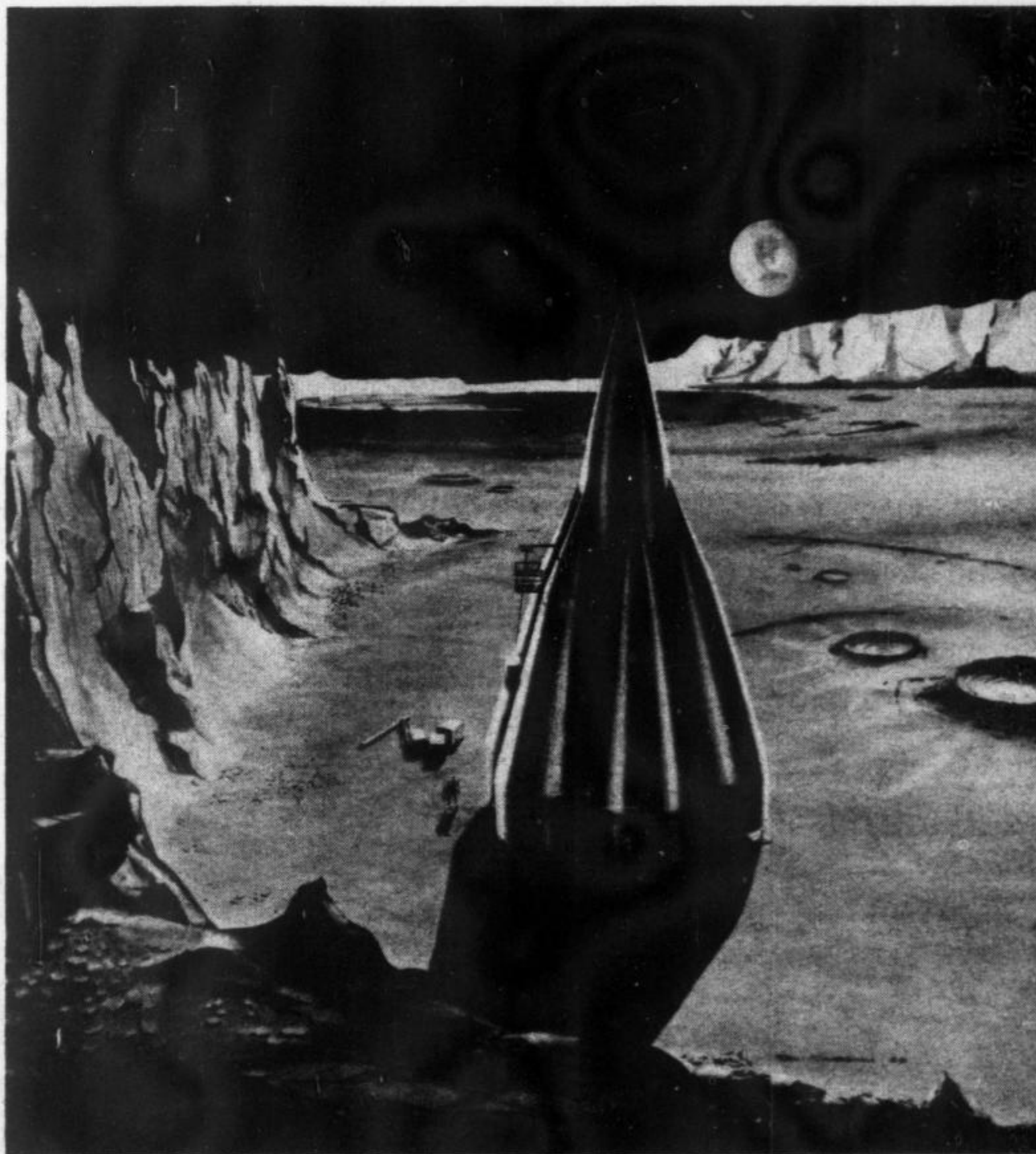
Unfortunately, rather high energy losses in the plasma system result from power dissipation as current flows in the external apparatus circuits, plus that used up in the initial ionization of the propellant.

It is not yet certain that the arc jet or plasma thrust will receive much utilization as space propulsion systems.

The Ion Drive. The most publicized of the electrical propulsion schemes is the heavy ion system which appears capable of very high specific impulse. An alkali metal propellant is ionized by a method such as boiling in contact with a hot metallic surface. An electrode accelerates the positive ions to high velocity while they are being focused by a magnetic system. A decelerating grid then enables adjustment in ion velocity.

A beam of electrons must be added to the ion beam to provide over-all system neutralization as it exhausts to produce thrust. This is probably the most serious

(continued on page 46)



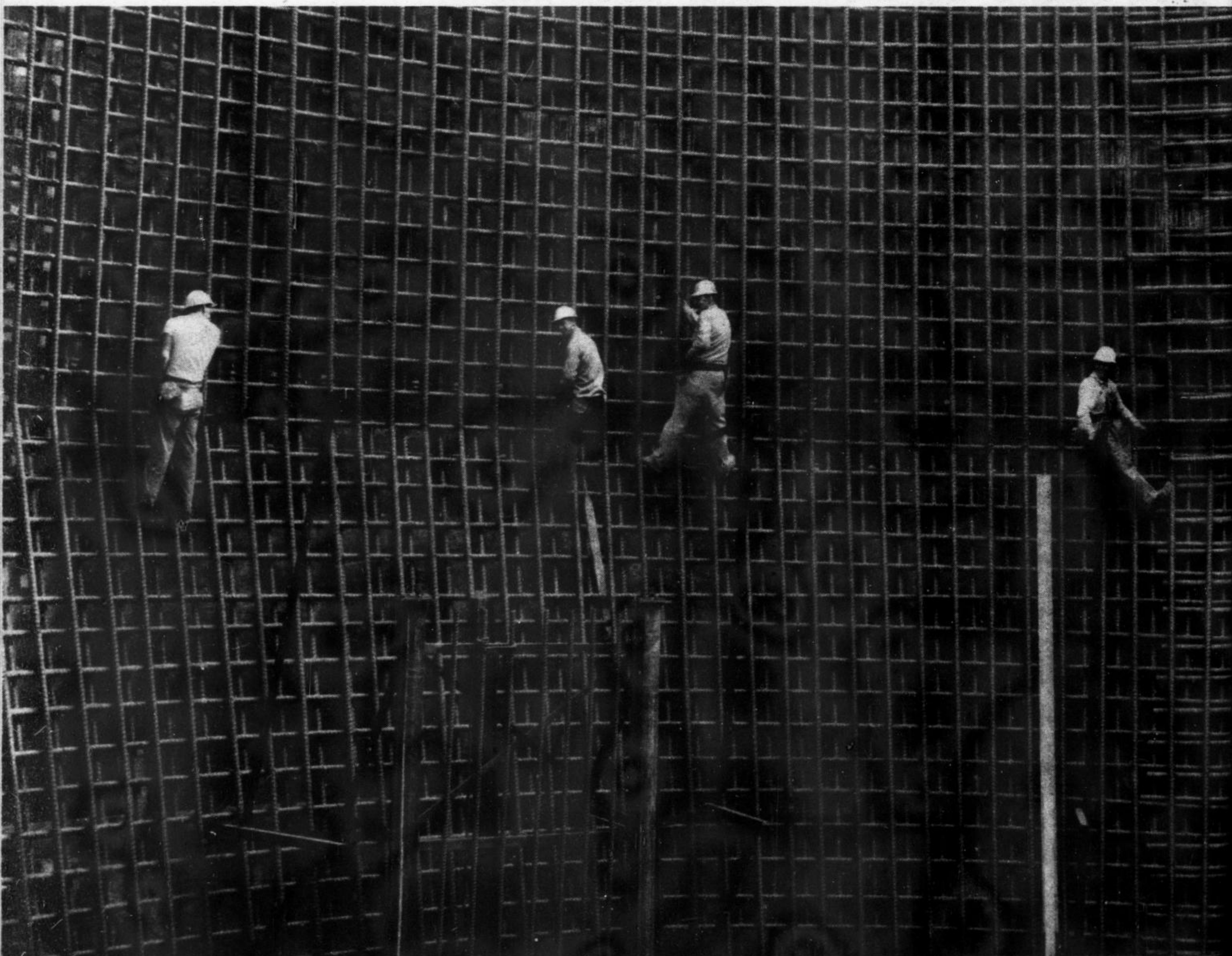
Nuclear-Powered Spaceship. Proposed single-stage rocket in artist's drawing will make large-scale lunar flight possible.

PICTURE NEWS



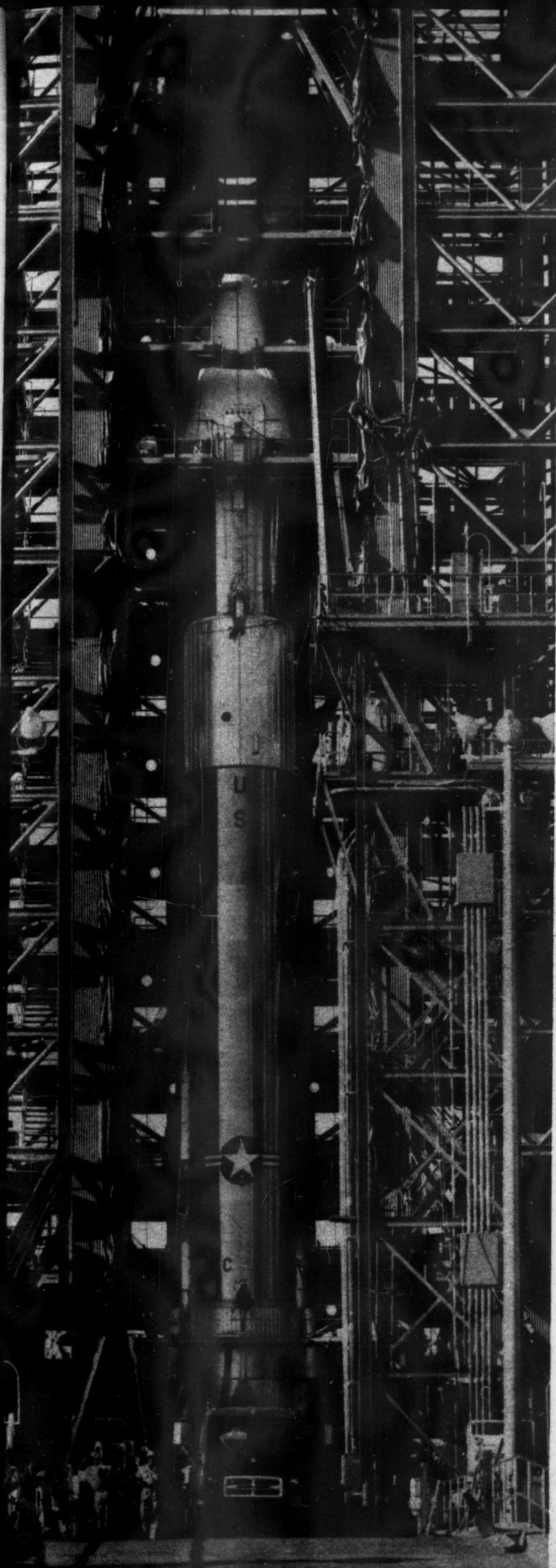
New Propulsion System. Avco engineer, left, checks out a new arc jet engine prior to placing it into vacuum chamber for a 2-day continuous test-run in a simulated space flight. Prototype engine, using helium as the working fluid, is being developed for use in satellites. It will provide power to control the altitude of a vehicle after it is in orbit.

Steelwork Ballet. Deep in an underground Atlas missile emplacement, these steelworkers might be performing an aerial ballet as they set reinforcing bars into walls of the 175-foot-deep enclosure. This "Silo" near Salina, Kansas, is one of a score of underground Atlas launch facilities being built at sites scattered from New York through New Mexico.

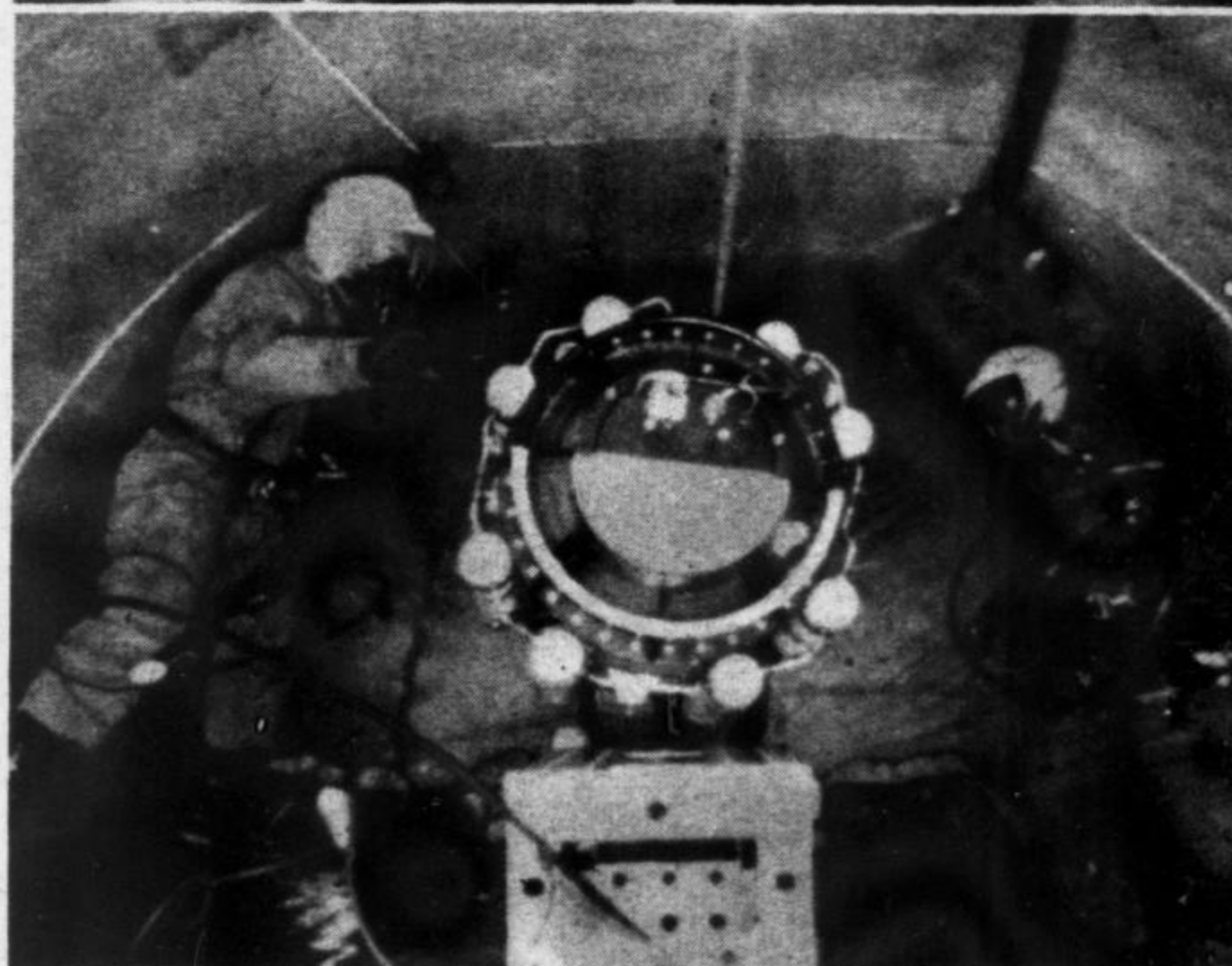


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New Top For Atlas. The 105-foot Atlas-Centaur space booster, left, is shown after erection on the complex 35 launch pad at Cape Canaveral. The giant vehicle consists of a modified Atlas ICBM, mated to the Centaur upper stage of similar stainless steel construction. The Centaur stage, however, will be the first space vehicle powered by liquid hydrogen fuel. This powerful combination will be used for launching lunar and interplanetary probe missions.



Weightless Test. Engineers prepare hydrogen capsule before subjecting the equipment to zero-g conditions in an Air Force KC-135 jet aircraft at Wright-Patterson AFB, Ohio. Engineers and capsule float in space, bottom picture, during a moment of zero-gravity. Experiment is part of exhaustive test program for liquid hydrogen fueled rocket engines.

NOVEMBER 50c

SPACE WORLD

The news magazine of Astro-Science

TO MARS —AND BEYOND

The exciting story of Project Parsecs

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NOVEMBER 1960

VOL. 1 — No. 4

SPACE WORLD

CONTENTS

ABOUT THE COVER

SPACE WORLD
The news magazine of Astro-Science

TO MARS — AND BEYOND
The new long range of Project PARSECS



Our cover: Alfred Kunen and Milton Minneman, Republic Aviation scientists, study prototype of Magnetic Pinch Plasma engine for interplanetary travel. The engine can theoretically drive a vehicle at a speed closely approaching the speed of light. A successful, working model has already been developed by Republic engineers. Planet Mars is in background.

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ARTICLES

- 8 **TO MARS — AND BEYOND**, by Wellwood Beall
Boeing Aircraft's Senior Vice President tells about Project PARSECS.
- 12 **HOW A SATELLITE IS MADE**, by John Rublowsky
How TIROS came into being — from original idea to finished hardware.
- 16 **BREAKING THE SPACE BARRIER**, by Otto O. Binder
You are there with the first American Astronaut to probe into space.
- 20 **WHAT I BELIEVE**, by Wernher von Braun
Our foremost missile expert discusses some future rocket developments.
- 22 **FISHING FOR MISSILES**, by Eric Moulton
A closeup of the men and ships that rescue our rockets from the sea.
- 26 **GETTING AROUND — WHEN WE GET THERE**, by Willy Ley
Moving around on the planets won't be easy. Here are some problems.
- 28 **EYES IN ORBIT**, by Ralph Tenner
A full report on America's extraordinary, so-called, spy satellite systems.
- 30 **AFTER SATURN — WHAT?** by Edward Reisen
These mighty boosters will soon revolutionize our thinking about space.
- 34 **ASTRO-CALENDAR**
A compilation of every major event in astro-science from 1926 to date.
- 38 **INTERPLANETARY FLIGHT: A SYSTEMS ANALYSIS**,
by Krafft A. Ehricke
Performance specifications of the rocket that will reach Venus and Mars.

DEPARTMENTS

- 4 **LETTERS TO THE EDITOR**
- 5 **BOOK REVIEWS**
- 6 **ORBITING AROUND**
- 43 **SPACE QUIZ**

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ORBITING AROUND

SPACE SHARPSHOOTING

Up until early 1959, all U.S.A. satellites were routinely launched eastward from Cape Canaveral into equatorial orbits. February 1959 saw Discoverer I hurled into the first polar orbit. In between these two extremes are an infinite number of "slantwise" orbits — which in 1960 we are starting to utilize. Transit I-B was shot *northeastward* across Europe, while Transit II-A was sent *southeastward* over South America. Their semi-polar orbits thus criss-cross to cover most of earth's oceans and serve almost all ships with navigational guidance. Our satellite shoots are hitting orbital "bull's-eyes".

NEXT?

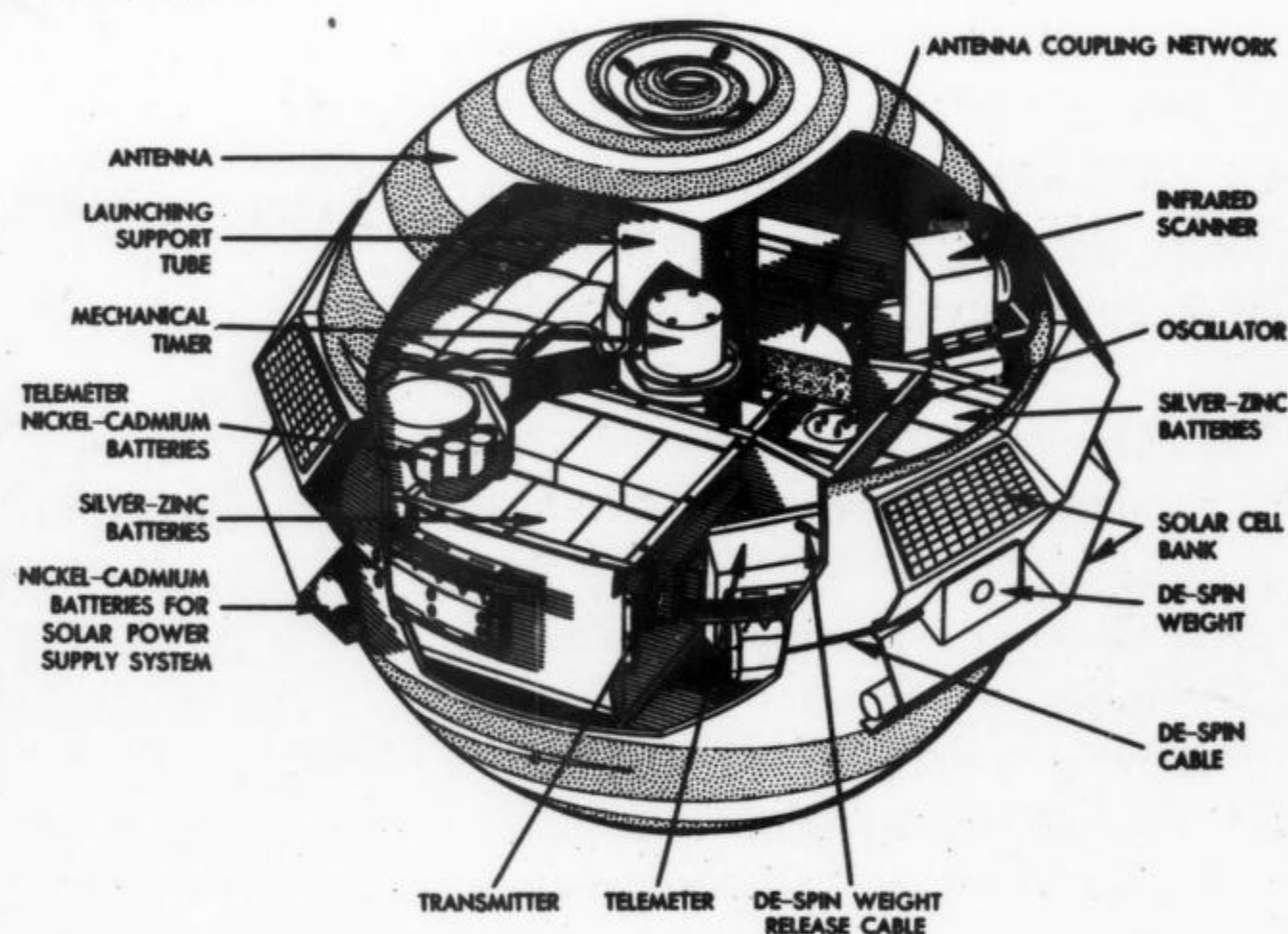
In the Space Race, the *win* and *place* entries have been chalked up to the USSR and U.S.A. Which nation will *show*? Only three Western nations have the economic/scientific muscle to launch complex costly space machines — England, Canada and France. The dark horse is Red China, rumored to be planning a 1961 launch of a "Peiping Probe" with a borrowed Russian booster. 1961 is also the target date for England, Canada and France to use NASA-loaned boosters for their own payloads. None of these 4 nations has named any firm date. Place your bets now as to which will join the exclusive USSR/U.S.A. Space Club as the third nation in space.

WANTED—SPACE LEADERS

Three top NASA administrators have announced their coming departure, starting with the Chief himself, T. Keith Glennan, and including Richard E. Horner, Deputy Director, and Homer J. Stewart, head of progress-planning. Whether money influenced their decisions or not, all of these talented men will earn far more in private industry. Many economists warn that our unrealistic policy of calling for "patriotic" sacrifices by brilliant space scientists, while closing the purse-strings, may result in a "management by mediocrity".

CONTROL

At radio ground-command, the original 170 rpm spin of Transit I-B was reduced, after 7 days in orbit, to 4 rpm. The restartable Star third-stage that lofted both Transits was reignited 20 minutes after the original boosting, to correct errors and create a near-circular orbit. Also, the spin rate of Tiros I was increased, via vernier jets, from 9.4 to 12.85 rpm—57 days after orbiting. Satellites are becoming "puppets" on strings pulled from the ground far below.



UNMANNED UFO?

Professor R. N. Bracewell of Stanford has a novel theory, based on mysterious radio "echoes" recorded in various years: they may come from a "communications probe" sent across space from another solar system's civilization. Rather than trying to ram weak signals directly across trillions of miles of intervening space (as is the premise of Dr. Otto Struve in Project Ozma), Bracewell thinks such people would launch a probe to our solar system and hurl strong signals to the nine planets nearby, hoping one is inhabited. This concept has not the slightest connection with "flying saucers" from outer space. Bracewell's unmanned "UFO" would be in orbit around the *sun*—to gather solar power for its radio—not darting mockingly through the skies (or imaginations of people on earth.)

THE TRUE "SPACE" MAN

Manfred E. Clynes and Dr. Nathan S. Kline, researchers of Rockland State Hospital (N.Y.) ask a bold question: Why must spacemen drag their costly and tricky earth environment with them? They have an equally daring answer: Adapt man to space instead. Suggested techniques: A solar-powered "lung" to eliminate his breathing; electrical heating for the brain, while "deep-freezing" the body; anti-radiation injections; finally, osmotic drug dosages to put him into "suspended animation" for long trips. In this state of controlled "hibernation", this literal *space* man could travel in an airless, unheated, unshielded spaceship, enormously reducing both risk and cost. They have named this ideal astronaut the "Cyborg" man—from cybernetics (robot devices) and organism. Their idea is quite as fantastic as Goddard's fool notion back in 1926 that liquid-fueled rockets could leave earth and reach the moon.

TOMORROW, THE SOLAR SYSTEM

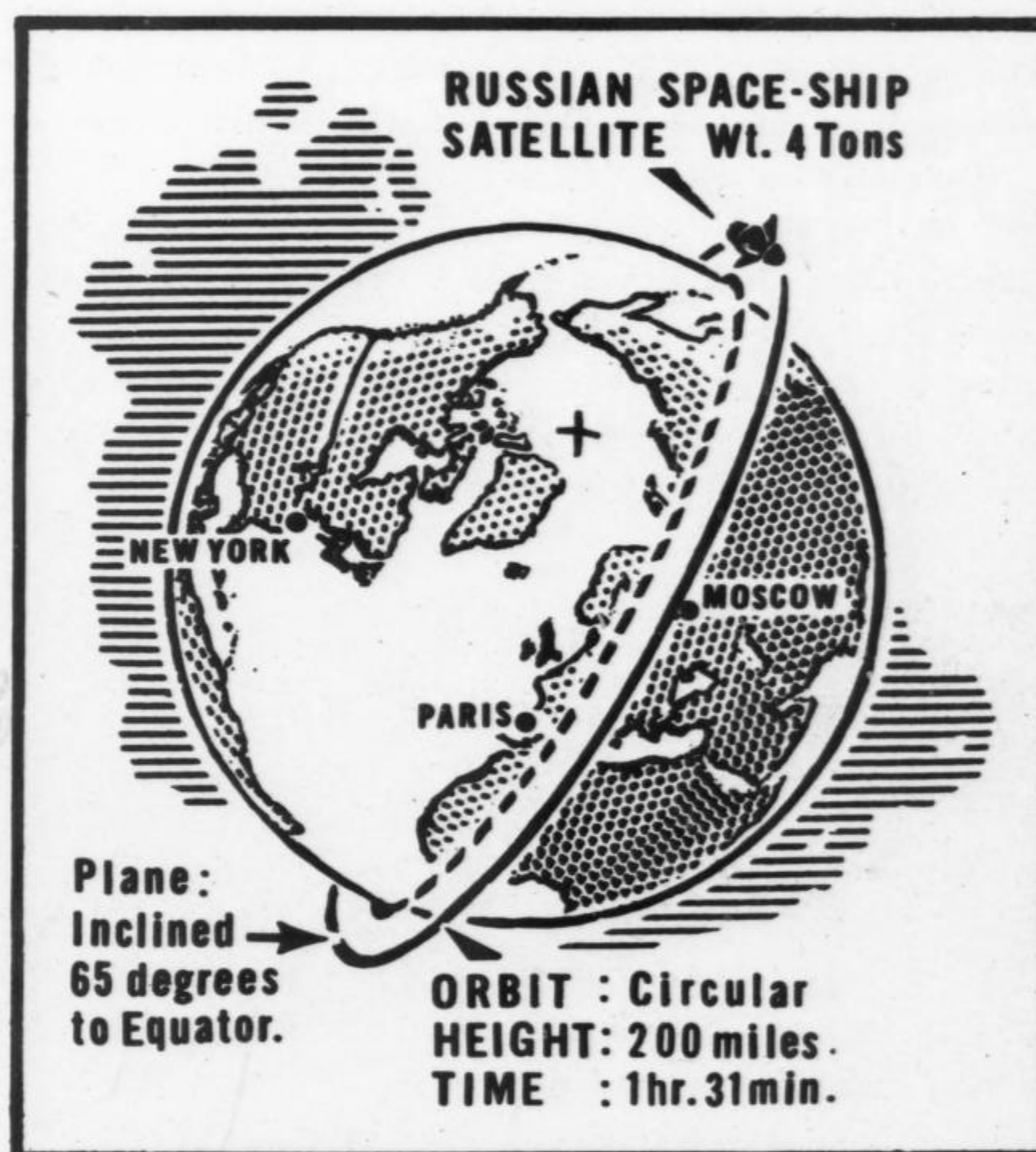
Dozens of America's biggest aerospace firms—Boeing, Convair, Martin, Douglas, to name a few—have prepared plans that would have been suitable for submission only to science-fiction magazines before Sputnik. Boldly, the proposed "systems" call for unmanned manned expeditions to the moon, Mars, Venus and points beyond within the *next 10 to 15 years*—1970 at the earliest, 1975 at the latest. These partly-engineered space blueprints, uncontaminated by blue-sky optimism, indicate that American private industry firmly thinks we are already turning that next corner—into the age of interplanetary travel.

PROBE PURITY

Exobiologists warn that mere ultra-violet sterilizing of planet-bound probes is not enough to kill all lurking microbes or viruses. These micro-organisms are fantastically hardy in the face of extreme heat, cold, radiation, even impact explosions. Hard-landing vehicles must be thoroughly fumigated with such powerful germicides as ethylene oxide, they say, or else earthly "germs" may be the first "pioneers" to land on the moon, Mars and Venus, to perhaps cross-breed with native species and contaminate them forever at a great loss to biological science. Also, soft-landing payloads with return ability must be sterilized in orbit, before landing on earth, or the vice versa will result—alien microbes spreading like wildfire here. Travel to the planets, while a triumph for space engineers, may be a worrisome headache for astrobiologists.

PALOMAR PARADOX

Palomar's Rudolph Minkowsky recently discovered the remotest known galaxy, an unthinkable 6 billion light-years away. It proves by its red-shift to have a velocity of 90,000 miles per second, almost half the speed of light. When even sharper-eyed orbiting telescopes track even remoter galaxies "expanding" outward at just under light-speed—then what? Will the *next* one be going *faster* and not be seen at all? Since this is "impossible" under Einsteinian theory, the Great Paradox again faces cosmologists. Either our "expanding universe" is expanding into an unknown "limbo"—or present-day theory is. Take your choice.



MYTHONAUT

Senator Henry Jackson (Washington, D) and others suspect there was a secret living "dummy" or cosmonaut in Sputnik IV, which Russia kept secret when reentry failed. No, says Willy Ley. His telling logic: Our own Mercury Astronauts, if both the automatic and ground-systems fail, will be able to manually bring their capsules down safely. In a crisis, the decision-making human brain can still top the best robot-brain. Under this reasoning Mr. Ley maintains the Sputnik IV reentry would *not* have failed if the "dummy" aboard lived and breathed. Obviously, no Cosmonaut entrusted with such a vital mission could have been a mental "dummy", making the major mistake of kicking himself higher into orbit instead of lower, even if the reentry later proved fatal through some unavoidable mischance.

TO MARS— AND BEYOND

by WELLWOOD BEALL

The planet Pluto is almost 4 billion miles from the sun. Beyond that, the nearest star is some 26 trillion miles away, or 4 and $\frac{1}{3}$ light-years. Between those two cosmic landmarks is an astronomical unit of measurement called the *parsec*—3.26 light-years, or almost 20 trillion miles.

Boeing has begun a study we call Project Parsecs, relating to space vehicles. We do not mean that such vehicles will go one full parsec into that vast gulf of space beyond our solar system. The name symbolically denotes how much further our studies go than present-day plans of the USA space program, which might be called the "Pluto" point.

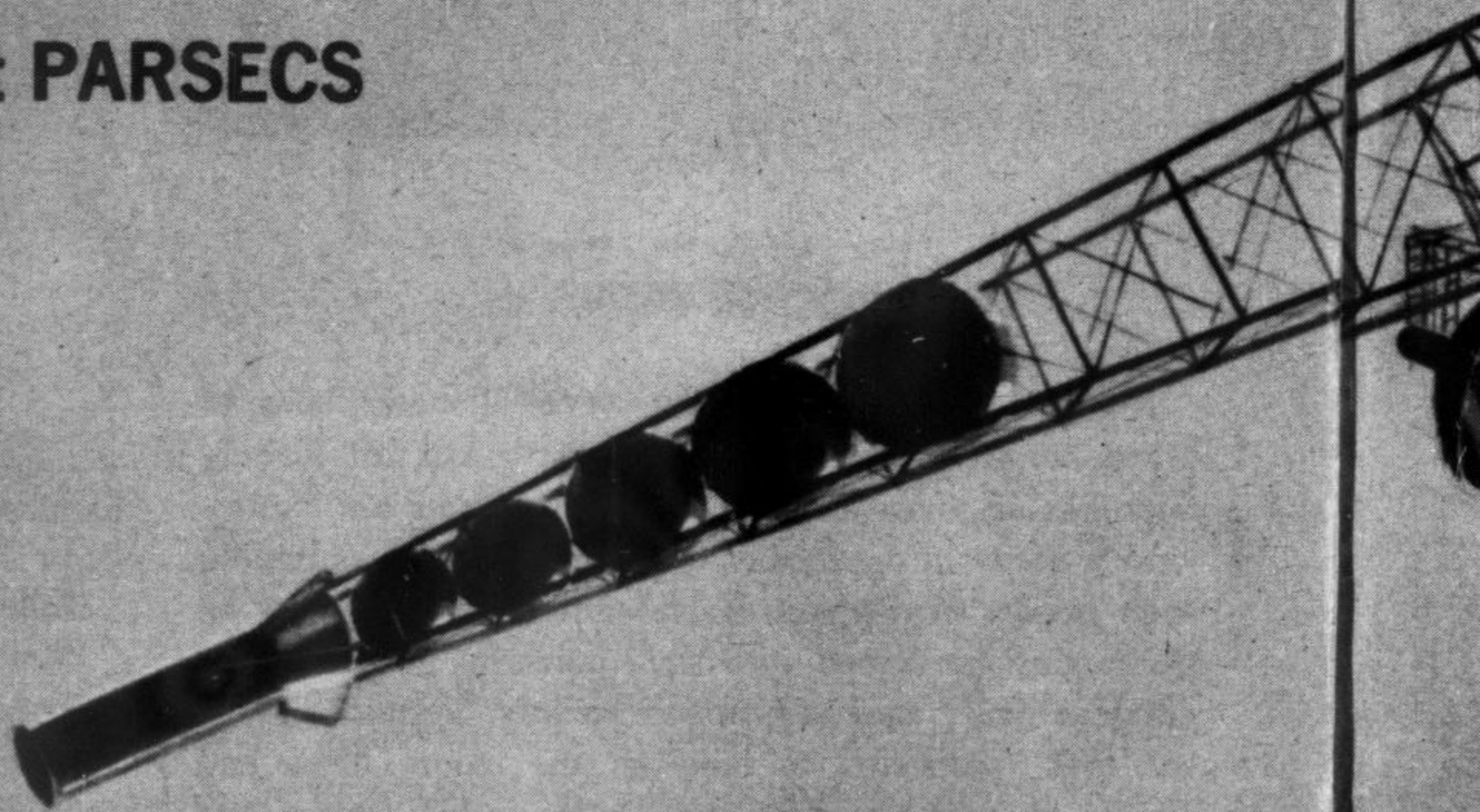
The Importance of Space Research

Project Parsecs proposes to project space research from the "Pluto" to the "Parsec" milepost. Parsecs is the letter-code for "Program for Astronomical Research and Scientific Experiments Concerning Space."

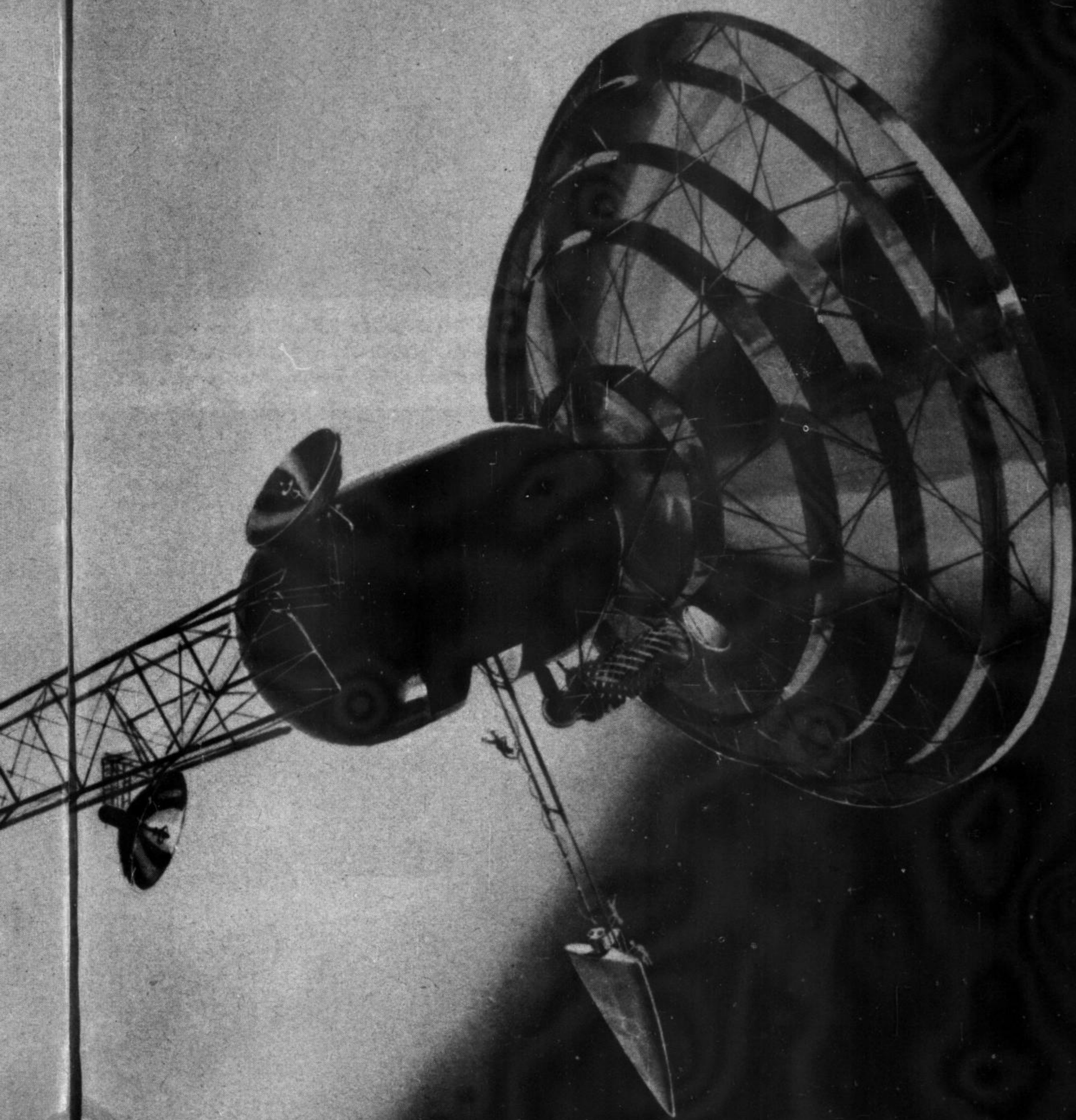
For this project, a series of unmanned advanced inter-

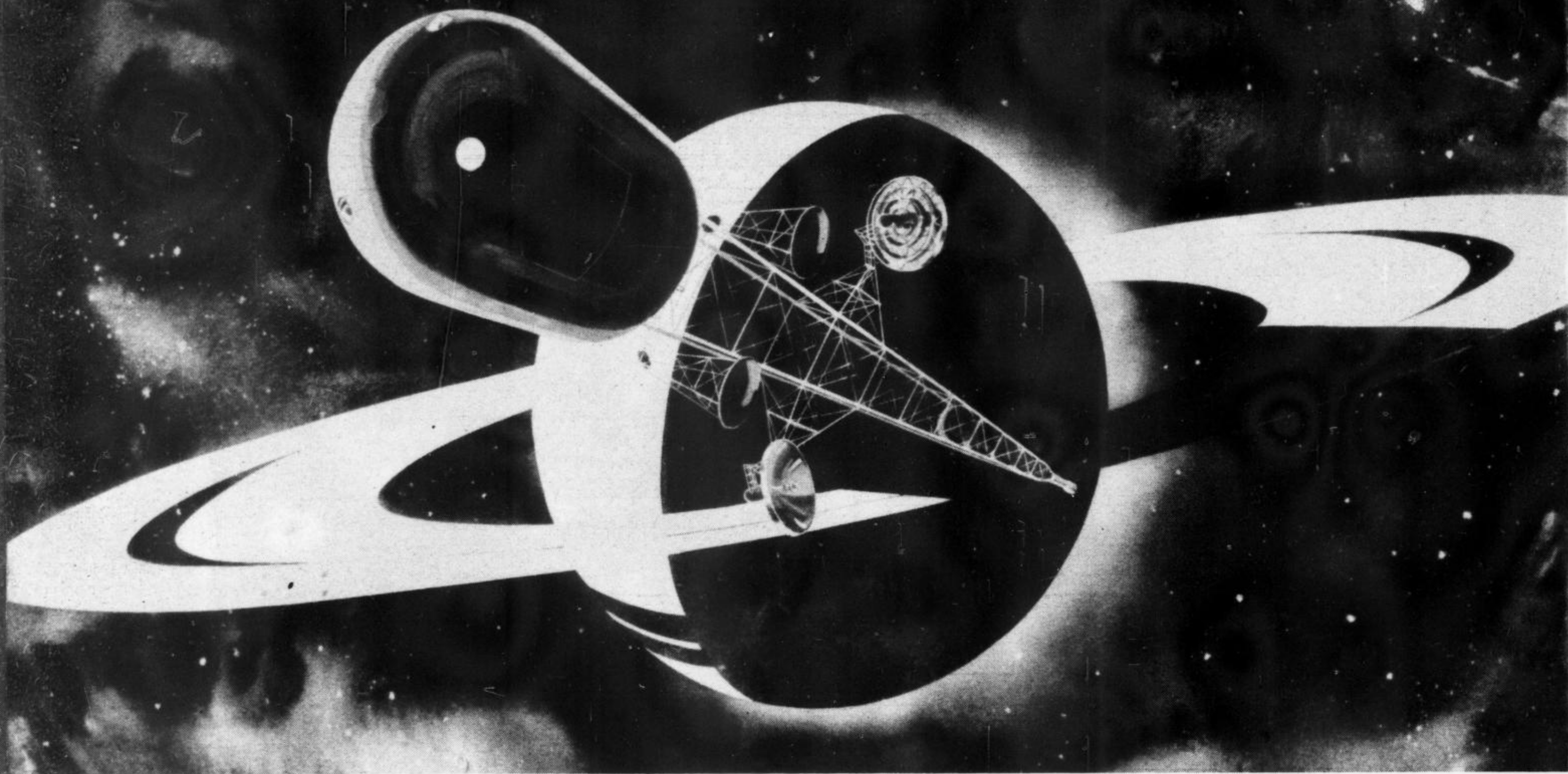
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**The Senior Vice President of Boeing Aircraft brings
you a report on Project PARSECS**



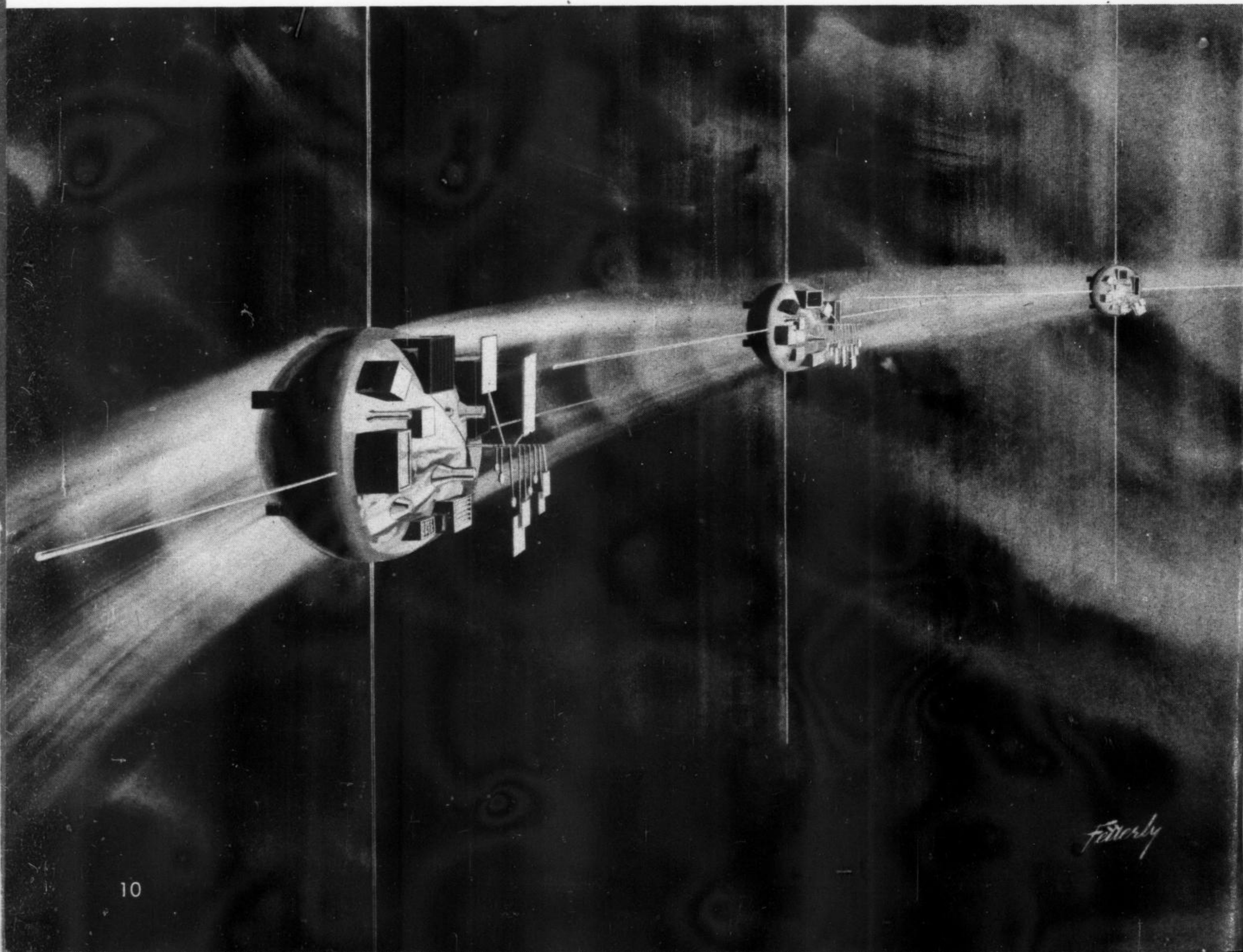
SATELLITE OBSERVATORY. An artist's conception of the astronomical laboratory in orbit above earth's atmosphere. This is projected as Mission I of Boeing's Project Parsecs and is in preliminary planning stage.





INTERPLANETARY VEHICLE. The proposed manned spaceship (above) will be capable of carrying a crew of 20 for exploratory trips to Mars & Venus. It can also be used for ultra-ecliptic orbit.

CLOSE SOLAR PROBE. This unmanned instrument probe (below) is designed to come within 10,000,000 miles of the surface of the sun. Special thermo-sensors will measure solar radiations.



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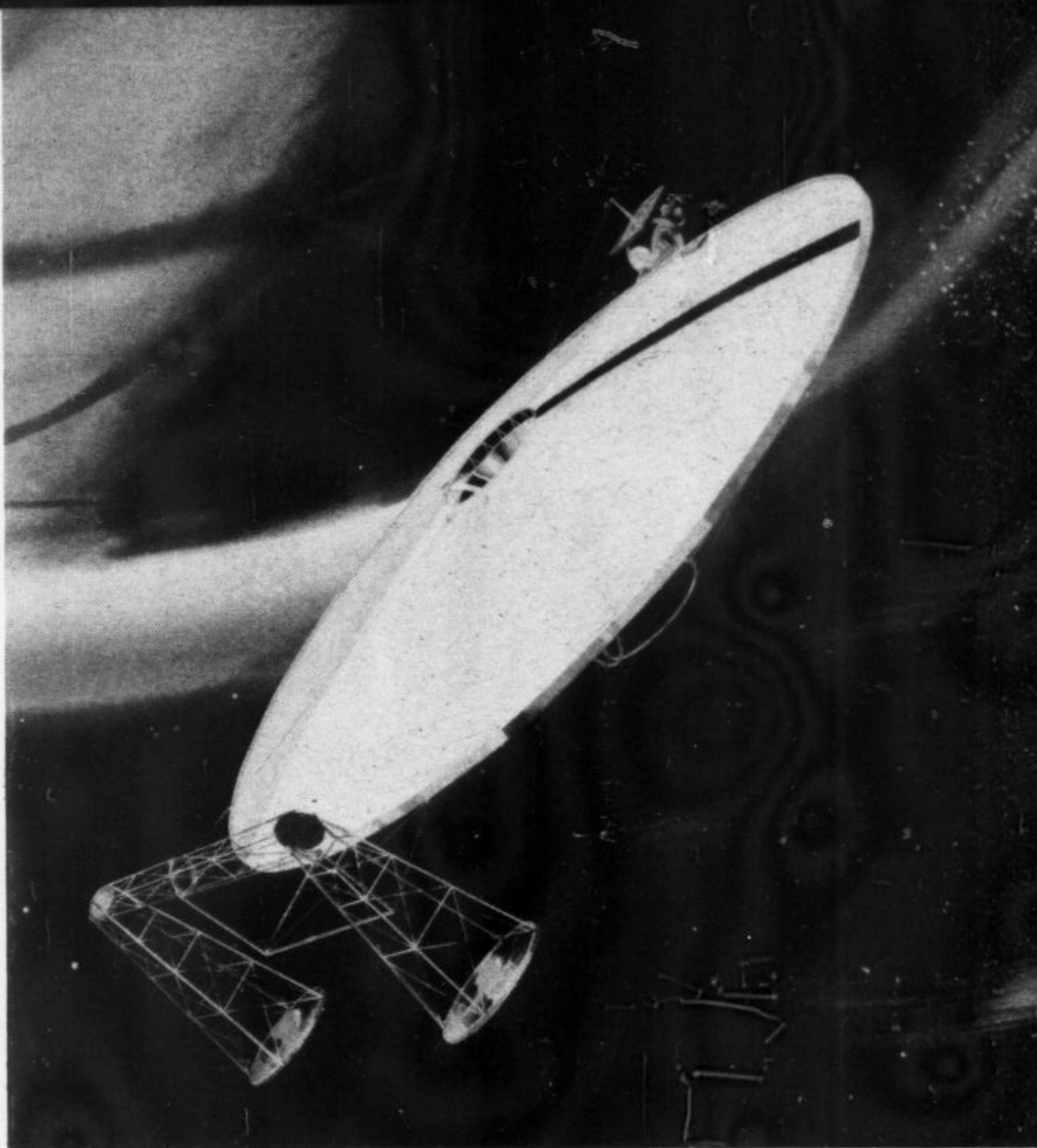
Rapid technological advances are moving up the timetable

planetary exploratory vehicles are being designed to pave the way for man.

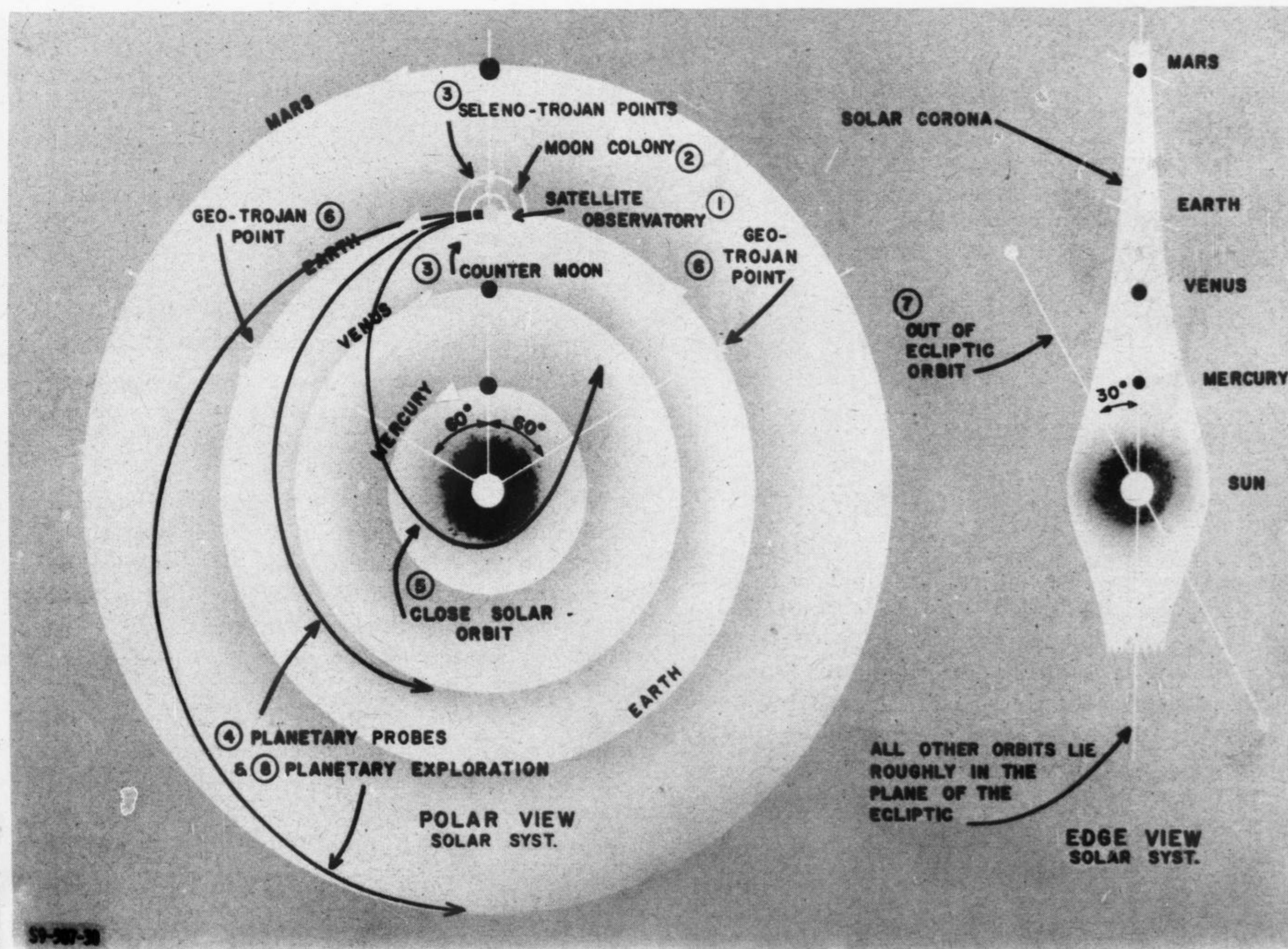
In our conception there are eight areas of interest beginning with the earth and its environs and extending into inter-galactic space. The farther up from earth we go, the more octaves of electromagnetic sun radiation we open up for investigation, from the longest radio waves down to the shortest frequencies of X-rays and gamma radiation.

On earth, when we say that the sun can be observed throughout the radiant spectrum, we really mean that it can only be "seen" through very restricted electromagnetic "windows" in the atmosphere. Thus, while the sun radiates powerfully in all wave lengths, we can read only

(continued on page 42)



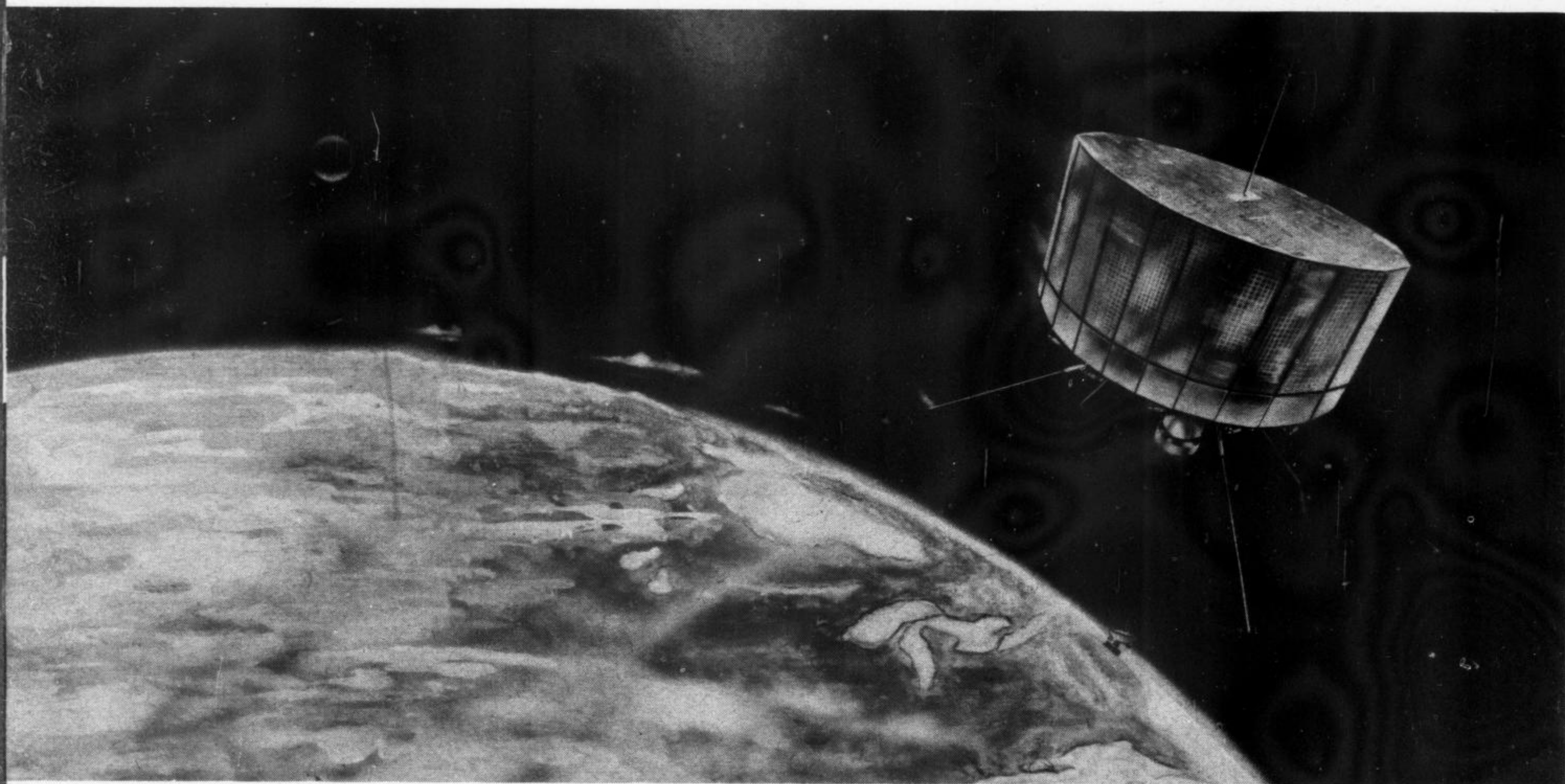
MARTIAN EXPLORER. This type of space vehicle could be constructed at orbiting space station before being launched towards planet Mars for instrument study and exploration.



PROJECT PARSECS. This diagram visualizes the scope of this Boeing Aircraft project that is presently being planned in detail.

HOW A SATELLITE IS MADE

An on-the-scene report from the lab where Tiros was born



IN ORBIT. Tiros is designed to take and transmit detailed pictures of the earth's cloud-cover from a 400-mile high orbit.

by **JOHN RUBLOWSKY**

"It's like adding a room to a house without a blueprint," said Edwin Goldberg, in his Texas drawl. "You add a little here, take off a little there and, for a while, it looks like the darn thing will never fit. But it all works out and the new room, though it isn't exactly what you originally planned, looks pretty good."

"Of course," he added with a wry grin, "building a satellite is just a bit more complicated."

Edwin Goldberg, a distinguished, gray-haired man with a slow, easy way of talking, is Project Manager of RCA's Astro-Electronic Products Division's TIROS Satellite System project.

Mr. Goldberg joined the engineering staff of RCA

in 1940 after receiving his M.S. degree in Electrical Engineering from the University of Texas. A specialist in development and design, Edwin Goldberg has 20 issued U.S. patents to his credit. When RCA organized the Astro-Electronic Products Division in 1958, he was named manager of the development and design section.

Under the direction of Mr. Goldberg and Vernon L. Landon, the engineering staff of this RCA subsidiary designed and built what has been described as the "most successful satellite to date."

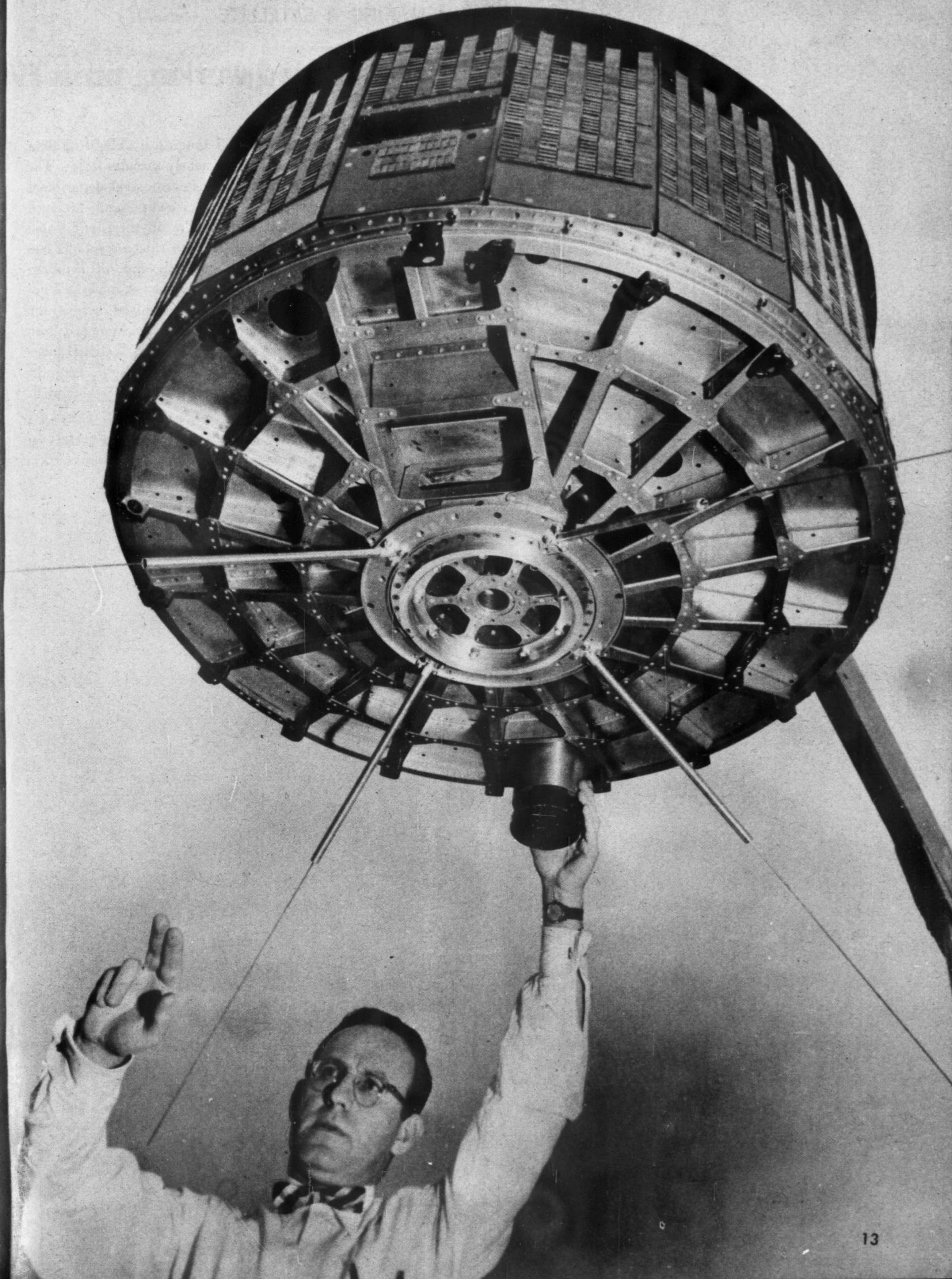
And the praise is well earned. Tiros I, speeding along
(continued on page 14)

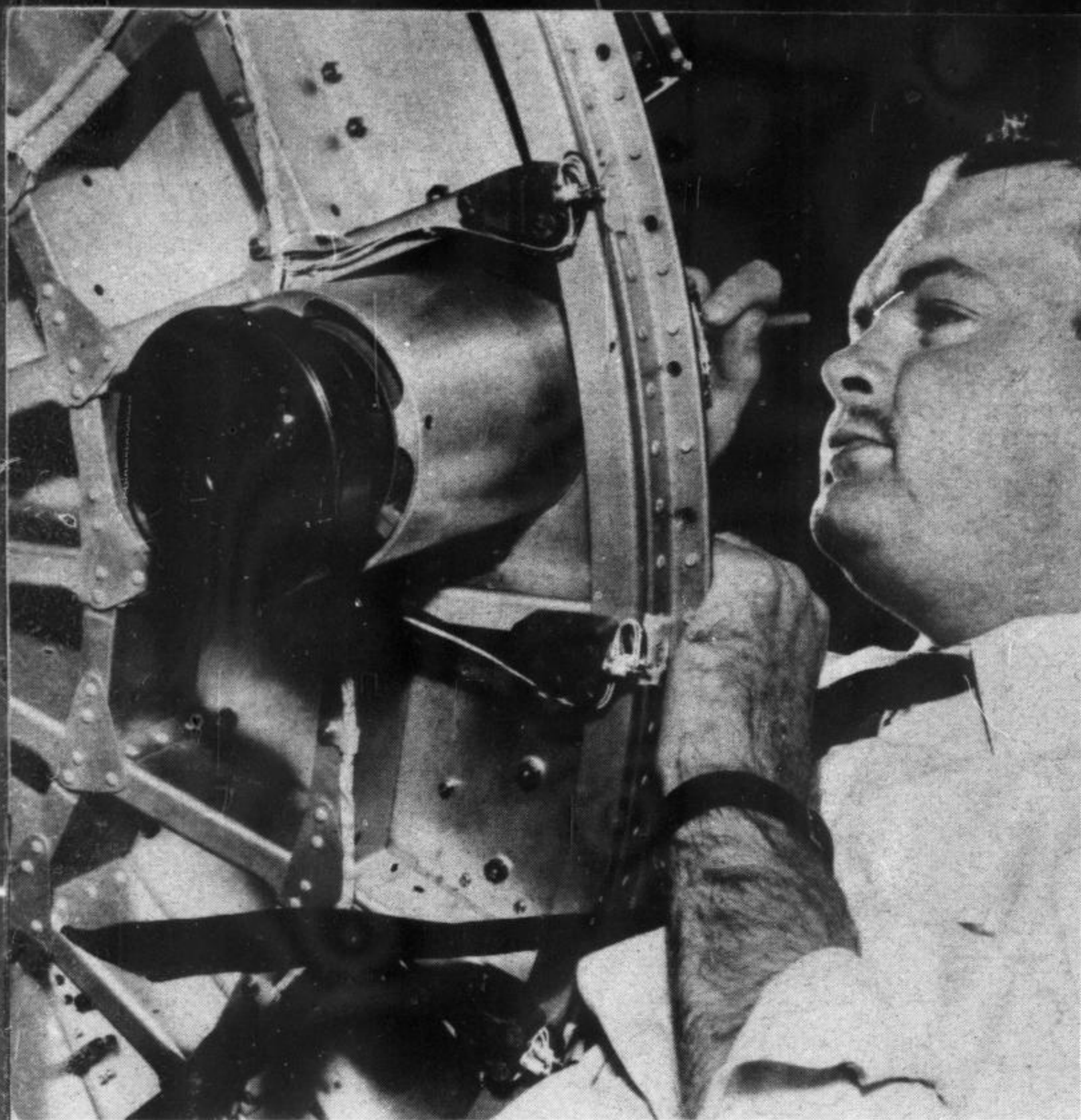
SOLAR TEST. Abraham Schnapf, assistant project manager, positions the satellite for outdoor tests of its solar power system. He holds the lens of the wide-angle television camera.

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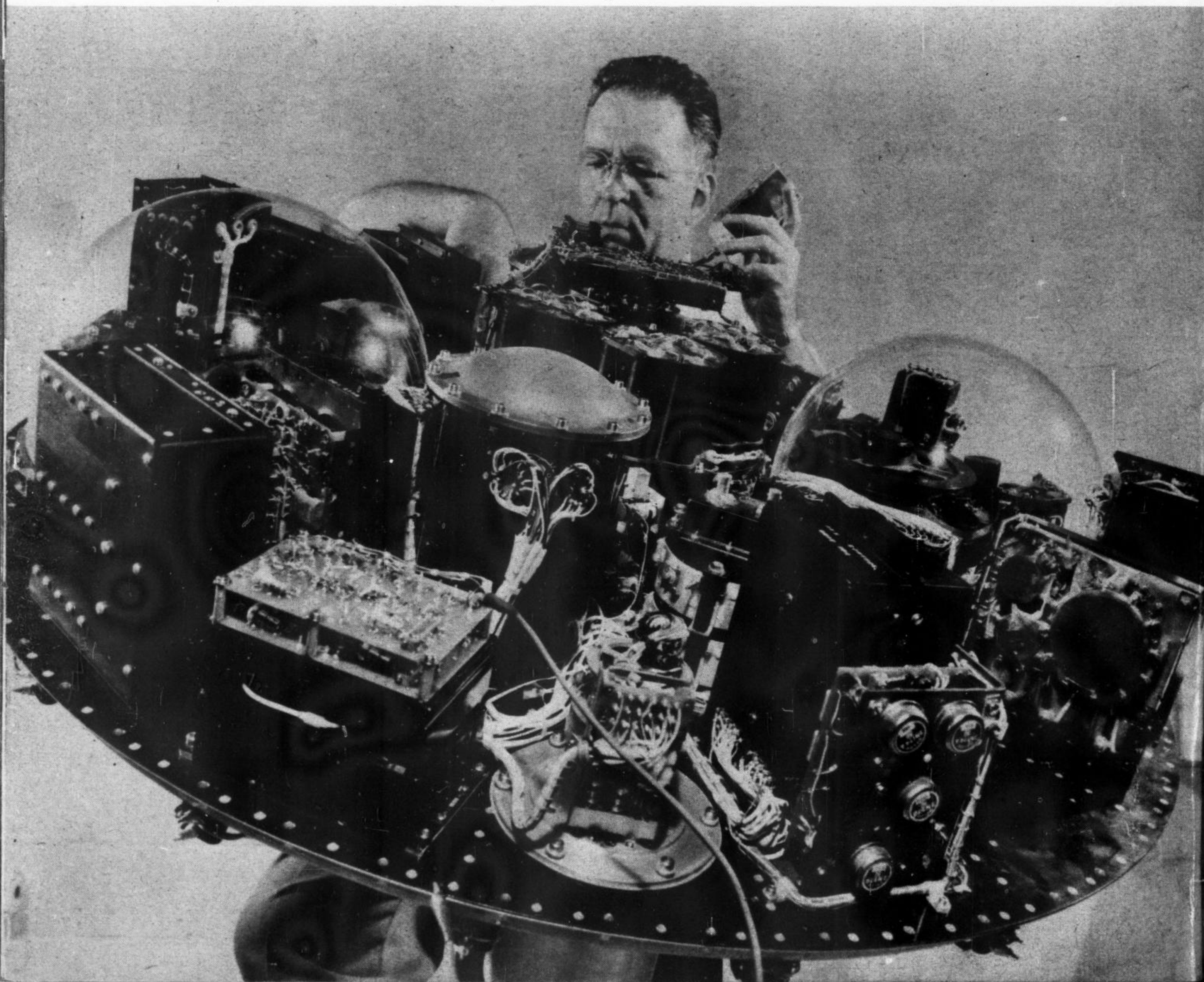
MAKING A SATELLITE *continued*

'We started working on a TV

its course in space, has been sending a deluge of data back from its 400-mile high, nearly circular orbit. The U. S. Weather Bureau, whose meteorological department has been processing the cloud-cover pictures received from the satellite, has had to take on three additional men recently, just to keep up with this torrent—22,000 pictures transmitted as of this writing, and still sending.

How, then, was this electronic marvel made? What were the problems that had to be solved before the smoothly functioning satellite could be launched into orbit? To answer these questions SPACE WORLD takes you to the Astro-Electronic Products Division center in Princeton, New Jersey to talk with the men who did it.

CONSTRUCTION. Rex Waddell, left, adjusts camera mechanism. Robert Schmicker, below, works on complex interior assembly.



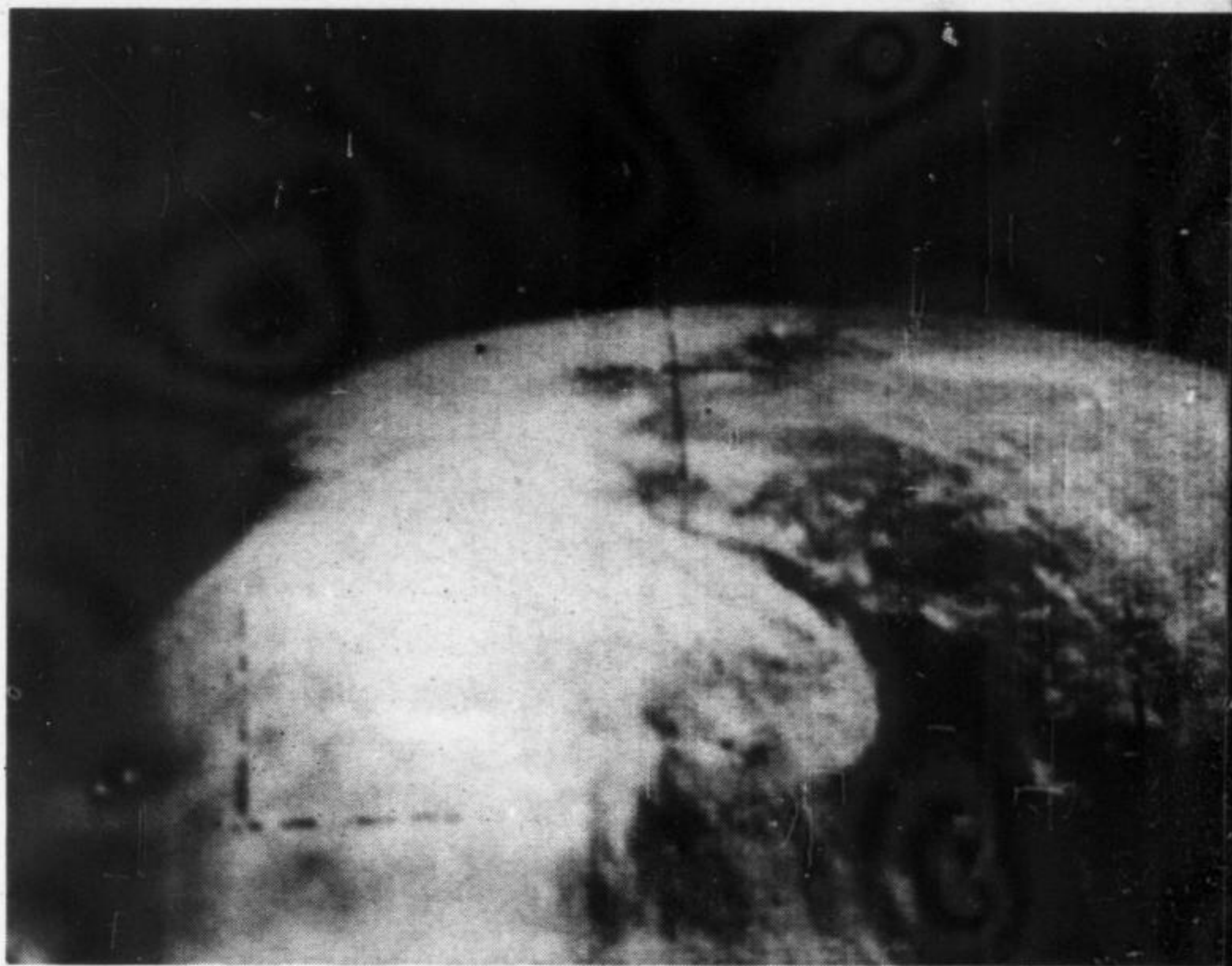
TV satellite as early as 1951'

The original concept of Tiros evolved during a series of meetings called by the Defense Department's ARPA (Advanced Research Projects Agency) early in 1958, to discuss the possibility of a TV-equipped satellite for obtaining detailed pictures of the earth's cloud-cover.

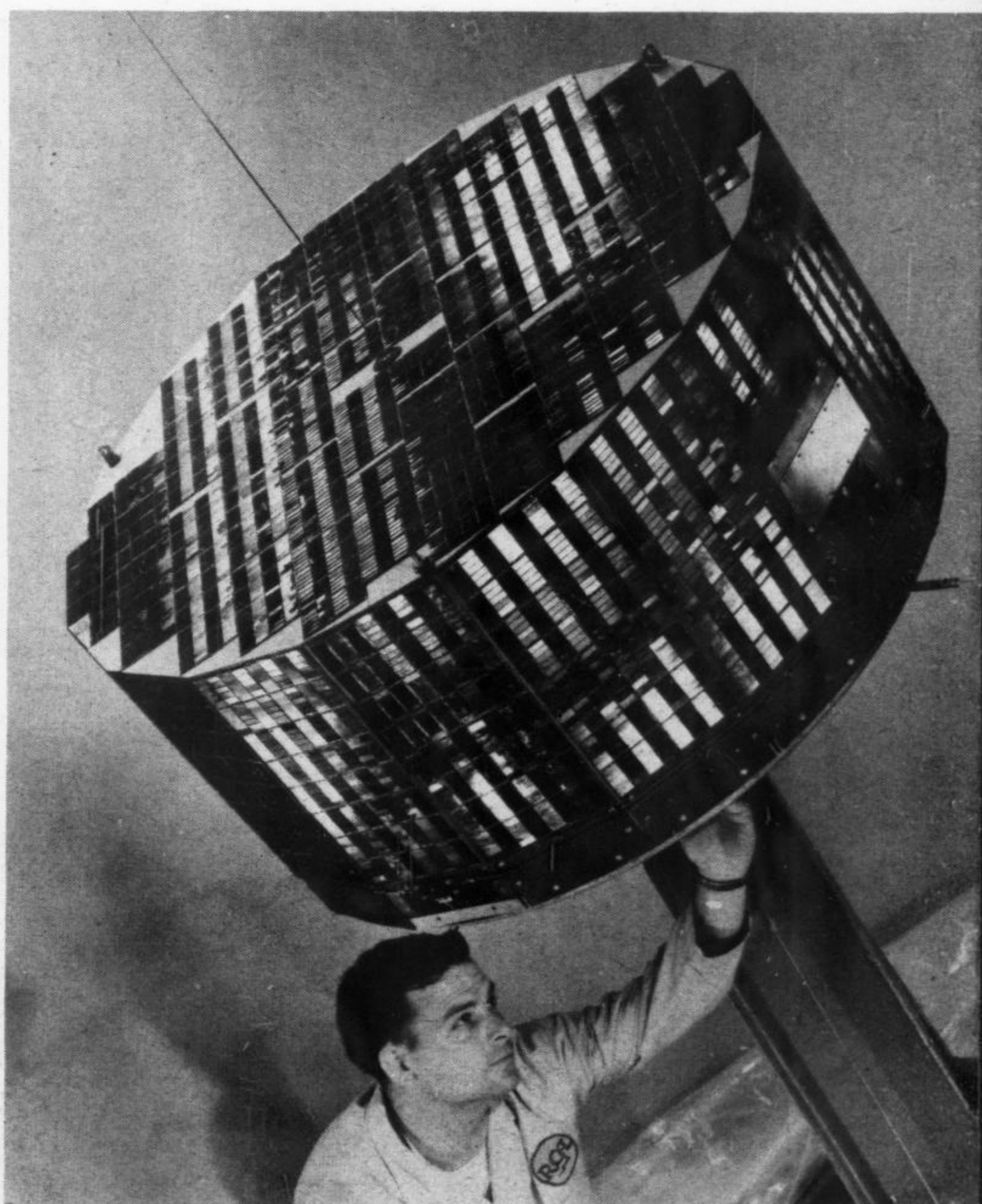
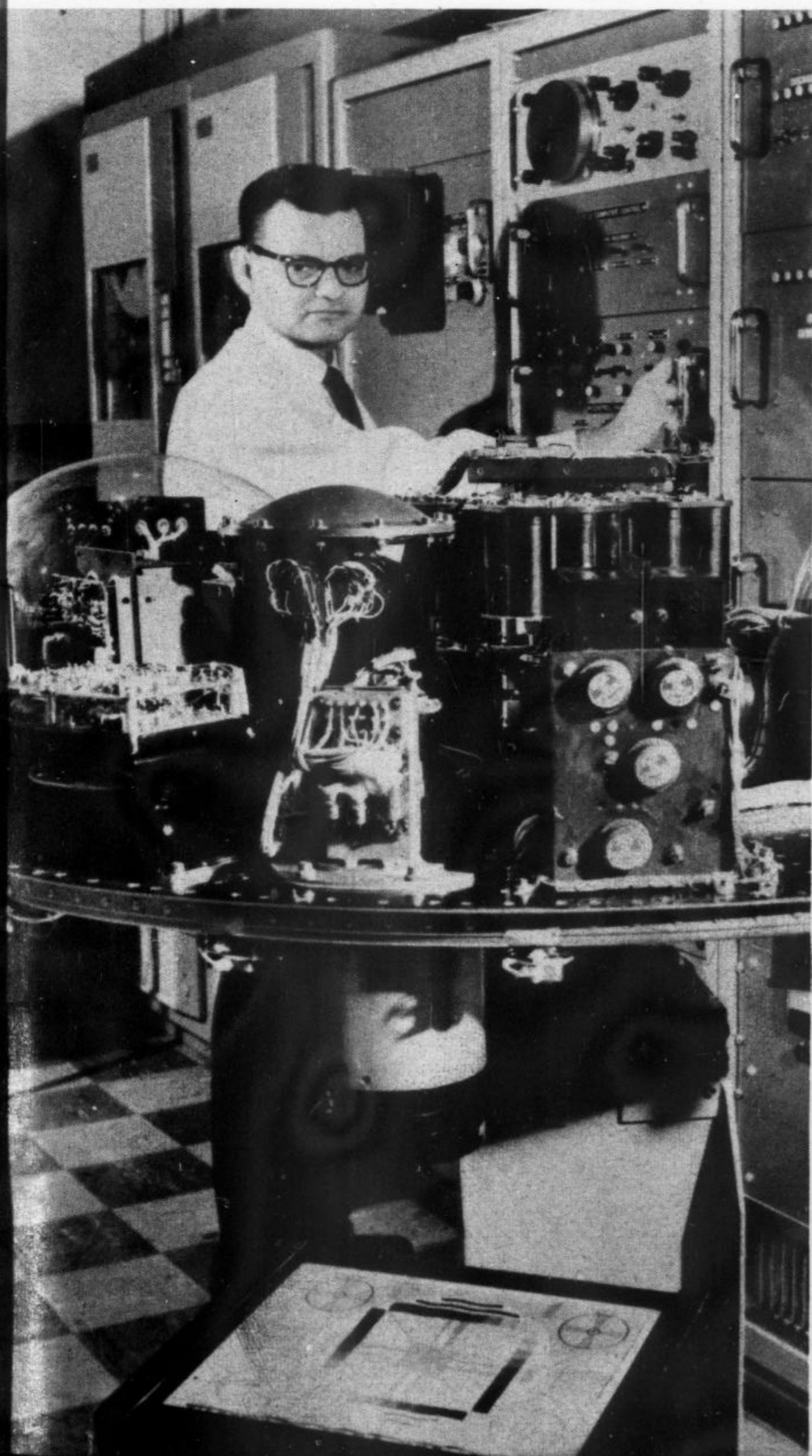
The experience of Vanguard II and other earlier satellites had demonstrated the technical and engineering feasibility of this kind of project. The U.S. Weather Bureau felt that the information that could be obtained from cloud-cover pictures would be invaluable towards a more complete understanding of weather phenomena.

Present at these meetings were representatives of the Weather Bureau, NASA, the USAF and the Cambridge Weather Research Center. RCA, which had already done pioneer work on TV satellites, was also invited to attend.

"Actually," said Sidney Sternberg, Chief Engineer of
(continued on page 45)



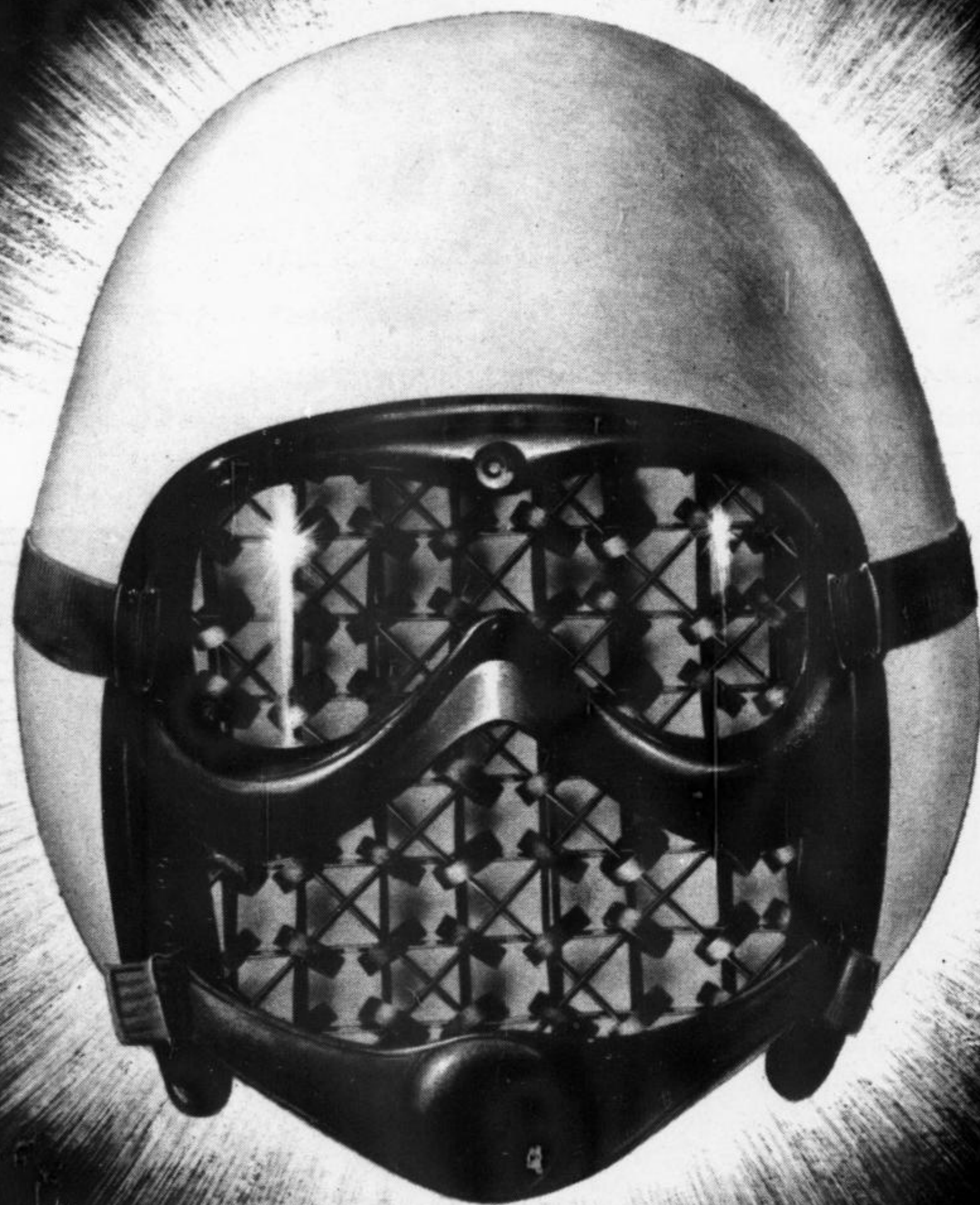
CLOUD PICTURE. Wide-angle camera transmits detailed photos to earth. Red Sea shore-line can be seen in lower right corner.



FINAL ADJUSTMENT. Technician readies the weather-satellite for its final testing phase before actual launching operation.

CHECK-OUT. The electronic sub-systems, mounted on circular base plate, are tested by Albert Aronson before getting okayed.

BREAKING THE SPACE E



E BARRIER

Any day now we may hear that the first man is soaring in space. Here is a preview of the experiences he will undergo

by O. O. BINDER

Astronaut Alpha steps out into the pre-dawn stillness at Patrick Air Force Base and swings into the waiting jeep. The corporal begins the drive to the launching pads at Cape Canaveral, 17 miles away.

Astronaut Alpha is ready to fulfill the role for which he has prepared through the long months since April, 1959.

Why has *he* been chosen from the seven Astronauts for this first sub-orbital flight of Project Mercury? He doesn't know. Only the brass, who held a selection conference the night before, know why he will be the first man in space, soaring 100 miles or more above earth.

The lights of Cape Canaveral appear. At the gate, the security guards glance at the Astronaut's pass. The jeep goes on.

Beyond, all the pads are dark, save one that is lit in the brilliance of searchlights. Over 200 technicians and engineers swarm up and down the spidery gantry, checking the Redstone bolt by nut. No booster has ever before been more carefully gone over.

"T minus 2 hours," booms the countdown from the outside loudspeakers.

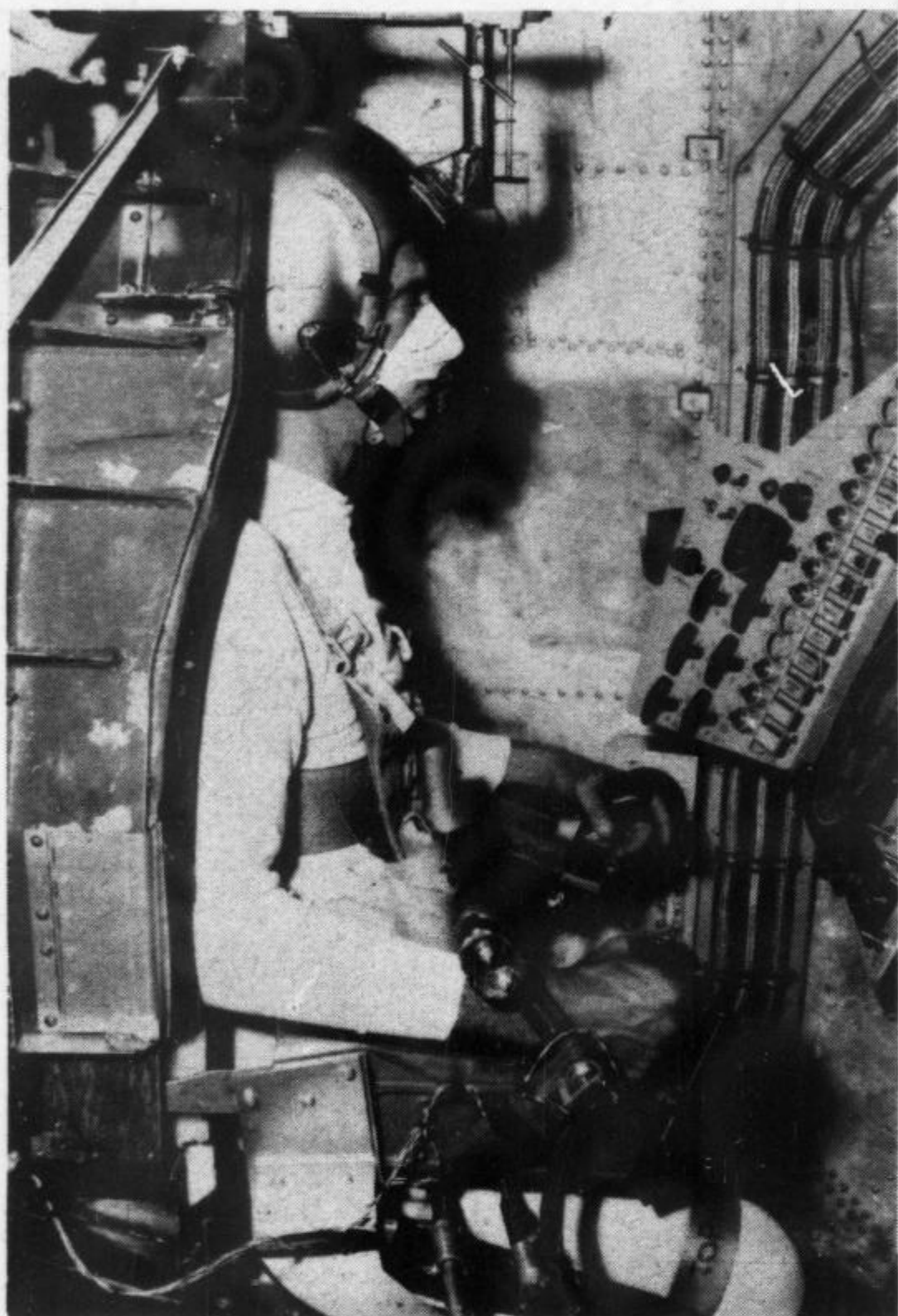
The jeep stops at the Mercury command headquarters. Six figures are waiting there to pump Astronaut Alpha's
(continued on next page)



SPACE PIONEERS. Shown above are the seven Americans chosen to train for the job of riding a satellite into space. NASA's timetable calls for one of these astronauts to be in orbit by 1961.

SPACE BARRIER

continued



HUMAN CENTRIFUGE. Astronaut Allen Bartlett prepares to ride as a living centrifuge in rehearsal of actual space flight. At right is artist's conception of the man-carrying Mercury capsule in orbit.



The Astronaut's tight Mark IV spacesuit

hand, all babbling at once in cheerful banter. His six Astronaut buddies are trying to loosen him up so the space medics won't strap in a bundle of raw nerves.

The space medics come out and take over. He is their creature now. Inside they routinely check pulse, respiration, eye-dilation. The Colonel in charge nods and says, "Strip, please, for your spacesuit."

The Space Suit

When Astronaut Alpha is nude, the aides help him into his "thermal union suit", followed by cotton underwear and socks. Then he is ready for his spacesuit, individually tailored for him alone. It is open like a jumper in front.

They help him get his feet in first, zipper the anklets, then put on the boots and secure the air-seals. Next, the jumper is pulled up around his hips and shoulders. He works in one arm at a time. It is all done slowly, with care to straighten out each seam. The tight, form-fitting suit feels like a strait-jacket after they zipper up the front

to the neck. Only the gloves and helmet are left. They will come later.

Perhaps only kings had ever worn outfits as expensive as Astronaut Alpha's Mark-IV spacesuit. It is \$3,750 worth of scientific tailoring based on exhaustive researches by the armed forces during high-altitude flights and innumerable space-simulator tests on earth. Its alternate layers of finely-woven nylon and rubberized fabric are coated on the outside with silvery aluminum to reflect heat. The problem in a spacesuit is not to keep warm but to keep cool. Up there, a confined man can roast in his own body heat. Later, when his helmet is on, cooling air will circulate between the layers of the suit. His private refrigeration system.

The discomfort of the tight suit soon vanishes. Previously Astronaut Alpha has worn it as long as 72 hours at a time during various tests — while sitting in a decompression chamber, riding a balloon gondola, facing roaring air-blasts in a wind-tunnel. He has also been subjected to temperatures ranging from 30 below zero Fahrenheit

uit fits like a strait-jacket

to 180 above, to a water submersion test and to dipping in a tank of brine while wearing the suit.

In all of these ordeals, Astronaut Alpha was snugly protected from the worst. He has faith in his suit, if it ever has to meet any space emergency lying ahead today.

"T minus 70 minutes," drones the intercom on the wall.

Now the Project Mercury brass come in to shake his hand, one by one. The chief clears his throat.

"Astronaut Alpha, you're purely a volunteer under no duress to go on. You have the choice of withdrawing now, no questions asked and without dishonor..."

Astronaut Alpha interrupts with a clipped, "No, sir. I'll go."

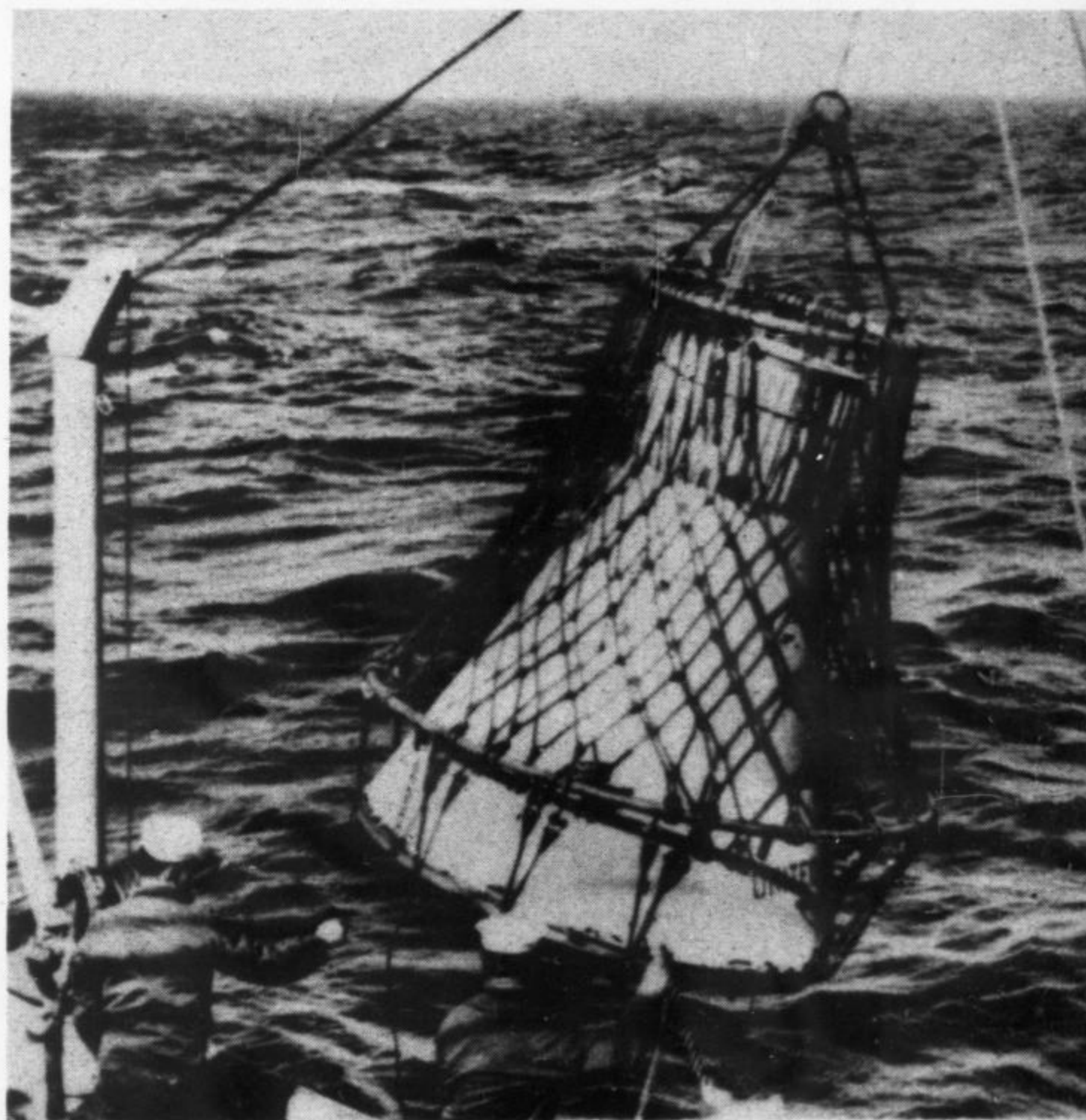
The chief leaves with his staff. The Colonel and his aeromedics take over again, like nursemaids, leading the waddling figure out toward the pad.

"T minus 60 minutes."

At this stage, there is still no certainty that the epic flight will take place. If the slightest malfunction of the

(continued on page 48)

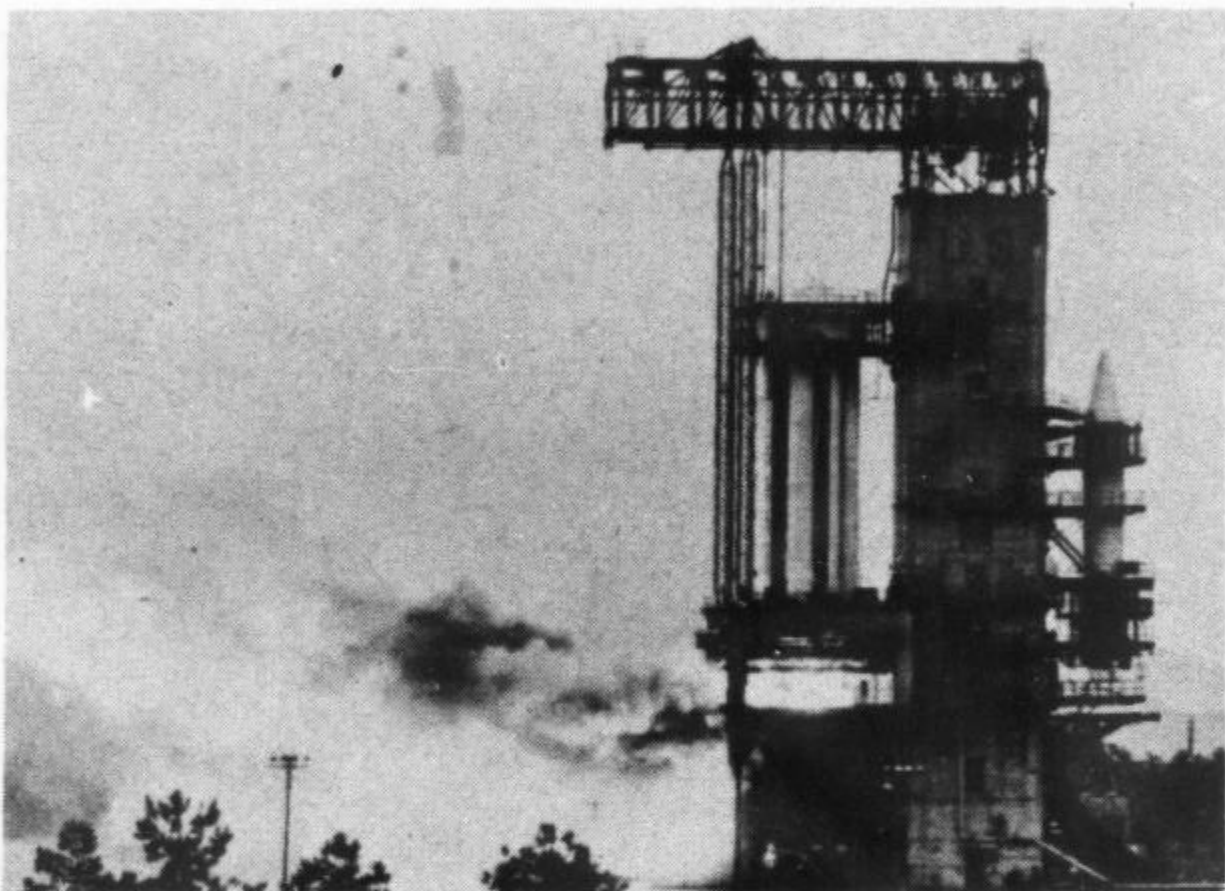
REENTRY. Mercury capsule (above) ejects stabilizing parachute when reentering atmosphere. Astronaut and capsule will be fished out of sea by Navy rescue teams (below).



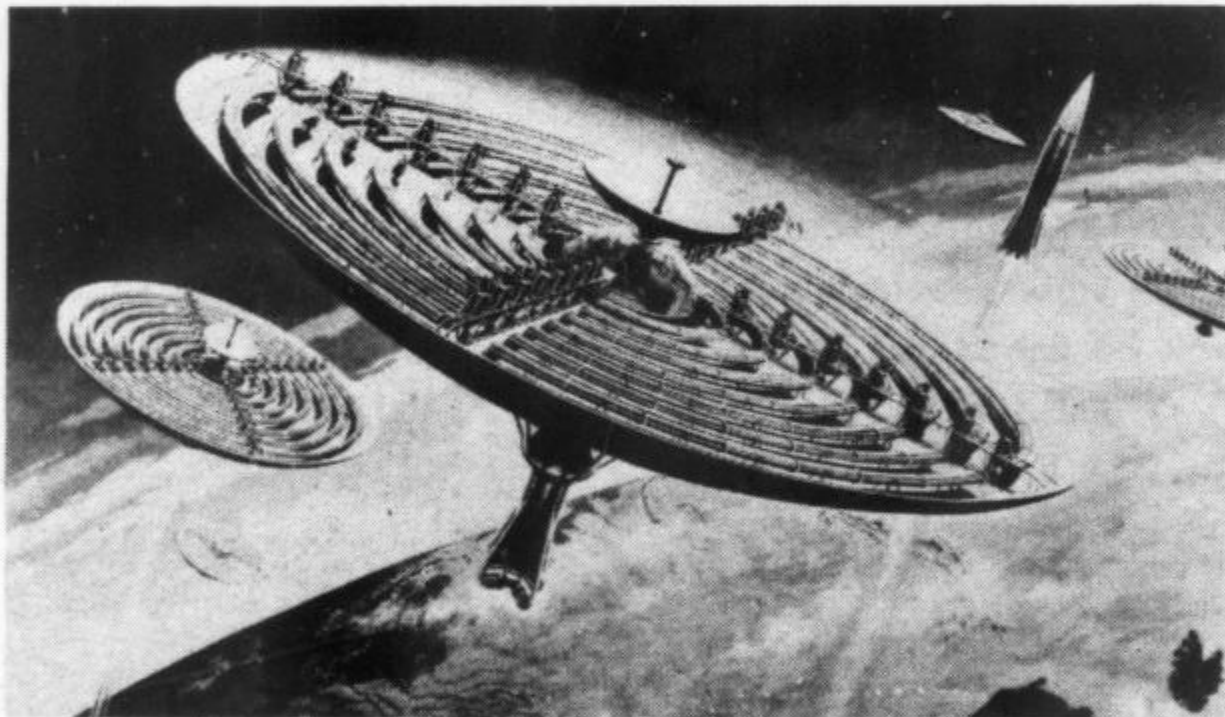
'WHAT I BELIEVE'

Our leading space scientist reports on some current problems—and their solutions

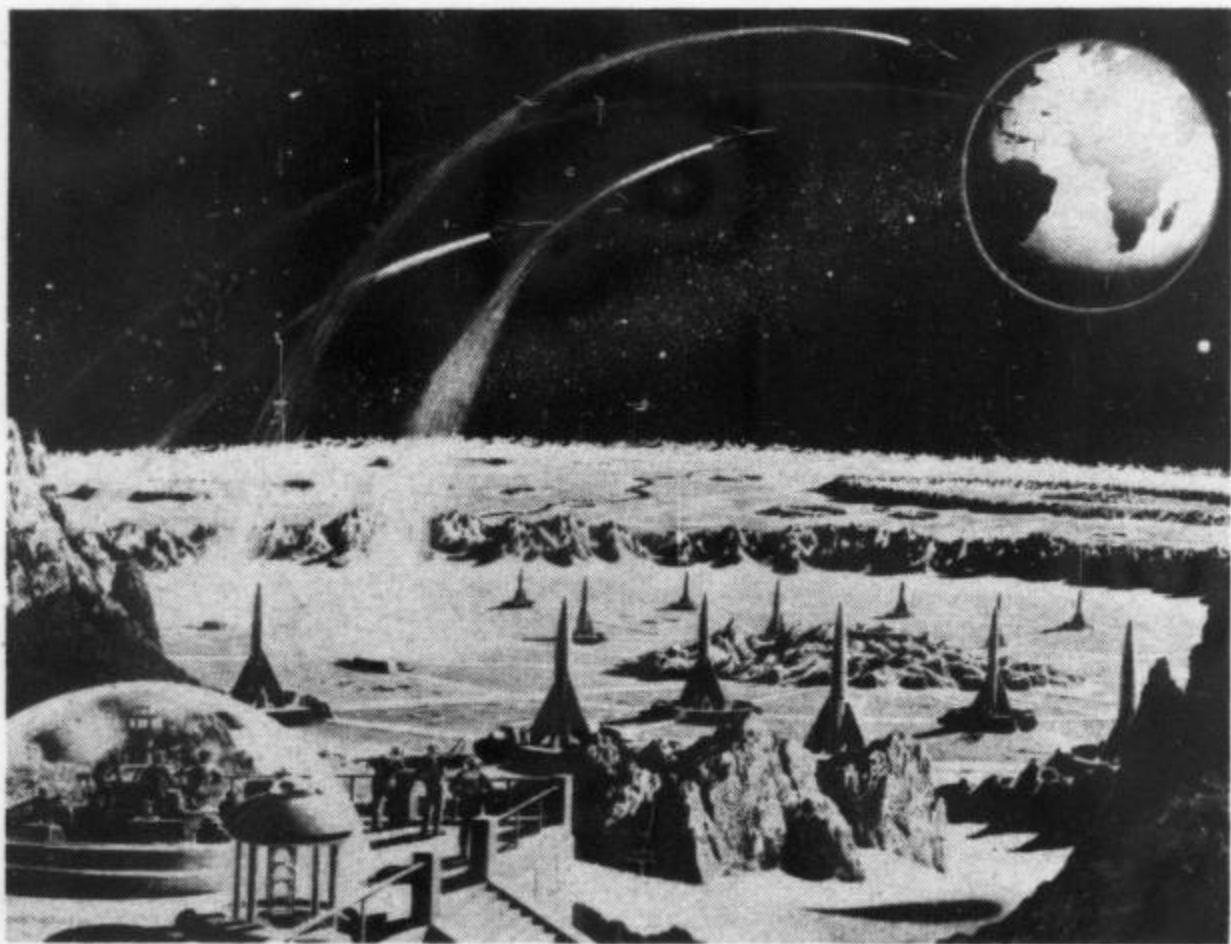
by **WERNHER von BRAUN**



SATURN. Von Braun's schedule calls for flight-tests by 1961.



SPACE STATION. 50,000 lb. payload will be lofted by Saturn.



MOON BASE. Saturn will soft-land 2,000 lbs. on the moon.

My associates and myself spent our first five years in America conducting exploratory work in rocketry for the United States Army. At the end of that period, we were more than ready to apply for citizenship, but it turned out that for the State Department we did not legally exist. So we had to leave the country and come back in again in order to satisfy the State Department's legal requirements for admission.

The Army thereupon arranged for some of us to go to Mexico, just across the border from where we were working on rockets at Fort Bliss, Texas. On my immigration certificate there is an item titled "vessel of entry". Normally, this is where you make such entries as "The Queen Mary" or "Ile de France". In my case, it simply reads, "Immigrated via El Paso street car."

From a street car to a moon ship may, as things turn out, be the order of progress in my part of America's space program.

Vacations in Space

A rather dubious visitor recently asked a young engineer in one of our laboratories what he thought of all this "space talk". The engineer replied, "When I first came here to work, it seemed more like science fiction than fact. But now I believe that in 50 years we'll be living on the Moon and commuting to work in Alabama!"

It is entirely conceivable, within our lifetimes, that rocket ships will be transporting people to vacations in space, and that some of the famous European spas will be competing with new "spas" on Venus.

If I seem confident about the future of our space effort, I also feel some misgivings. How well will we fare next year, the year after that, and 10 years hence? For the space program will attain its fullest possible development *only* if it continues its present pace and level of funding.

(continued on page 52)

THE AUTHOR. 83 days after getting authorization, Von Braun put our first satellite, Explorer I, into orbit. As leader of Saturn project, he looks forward to moving men through space.



GETTING AROUND —when we get there

by **WILLY LEY**

A leading space authority discusses
a problem that has received little
attention: intra-planetary travel...

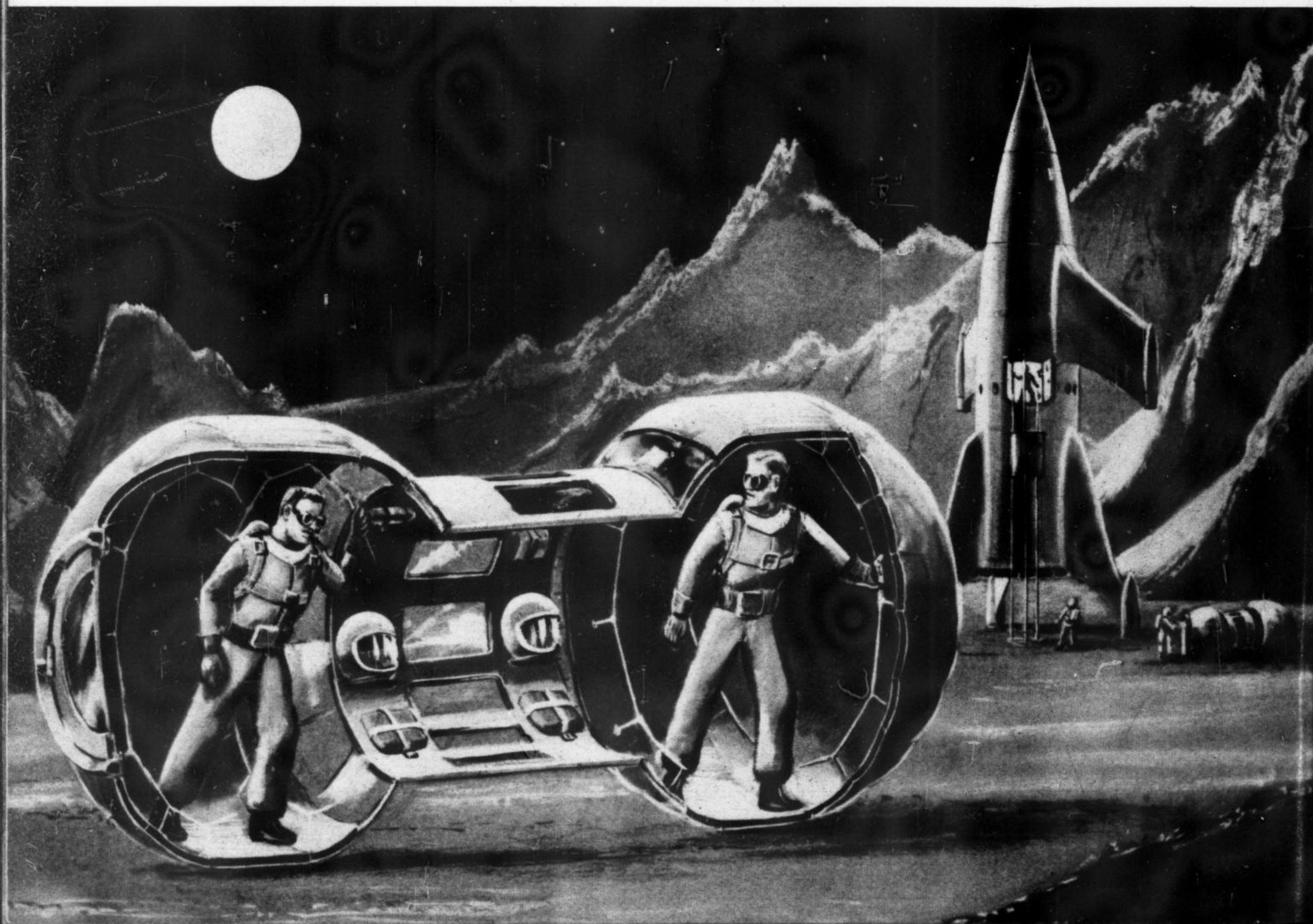
The pilot sets the spaceship down neatly at the edge of the *Mare Imbrium*, a few miles south of the ring-wall crater Plato. The expedition has safely landed on the moon.

Fine! Now what?

Or ... the power glider, after breaking out of its arrival orbit around Mars, successfully sheds its surplus speed in the thin Martian atmosphere and skims to a stop in the Martian desert.

Again: what comes next?

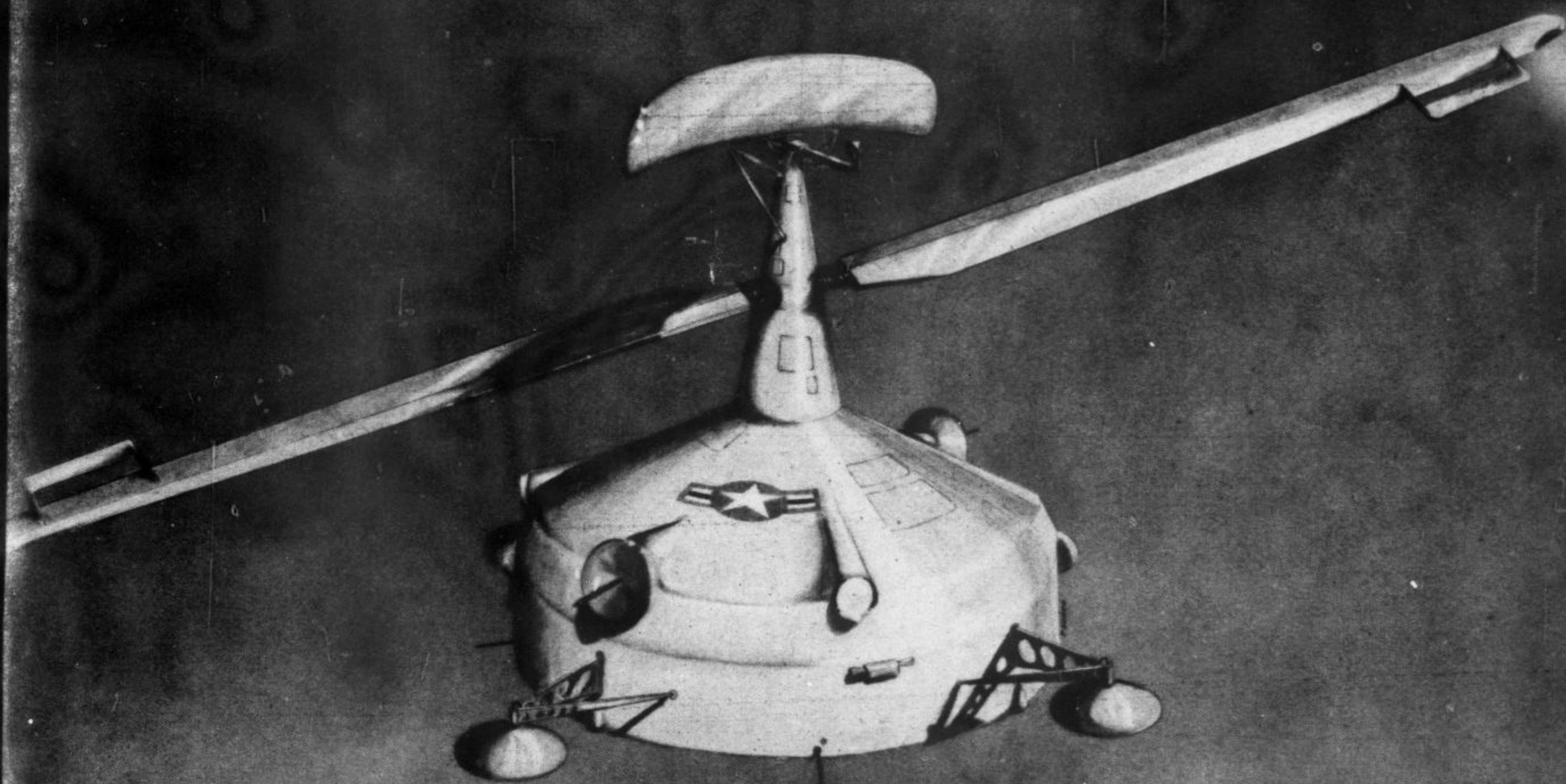
Obviously, the next step in each case is to get around
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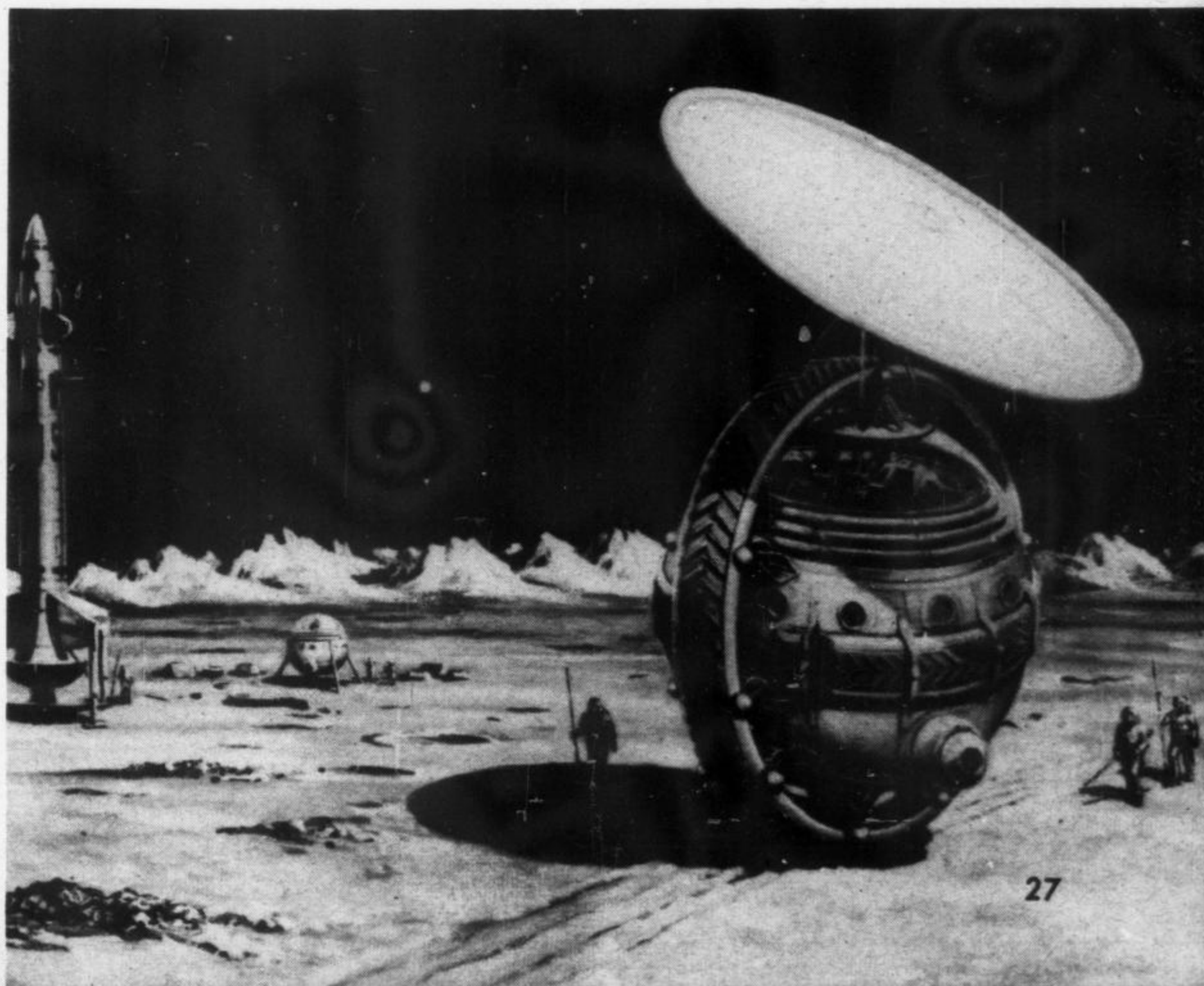
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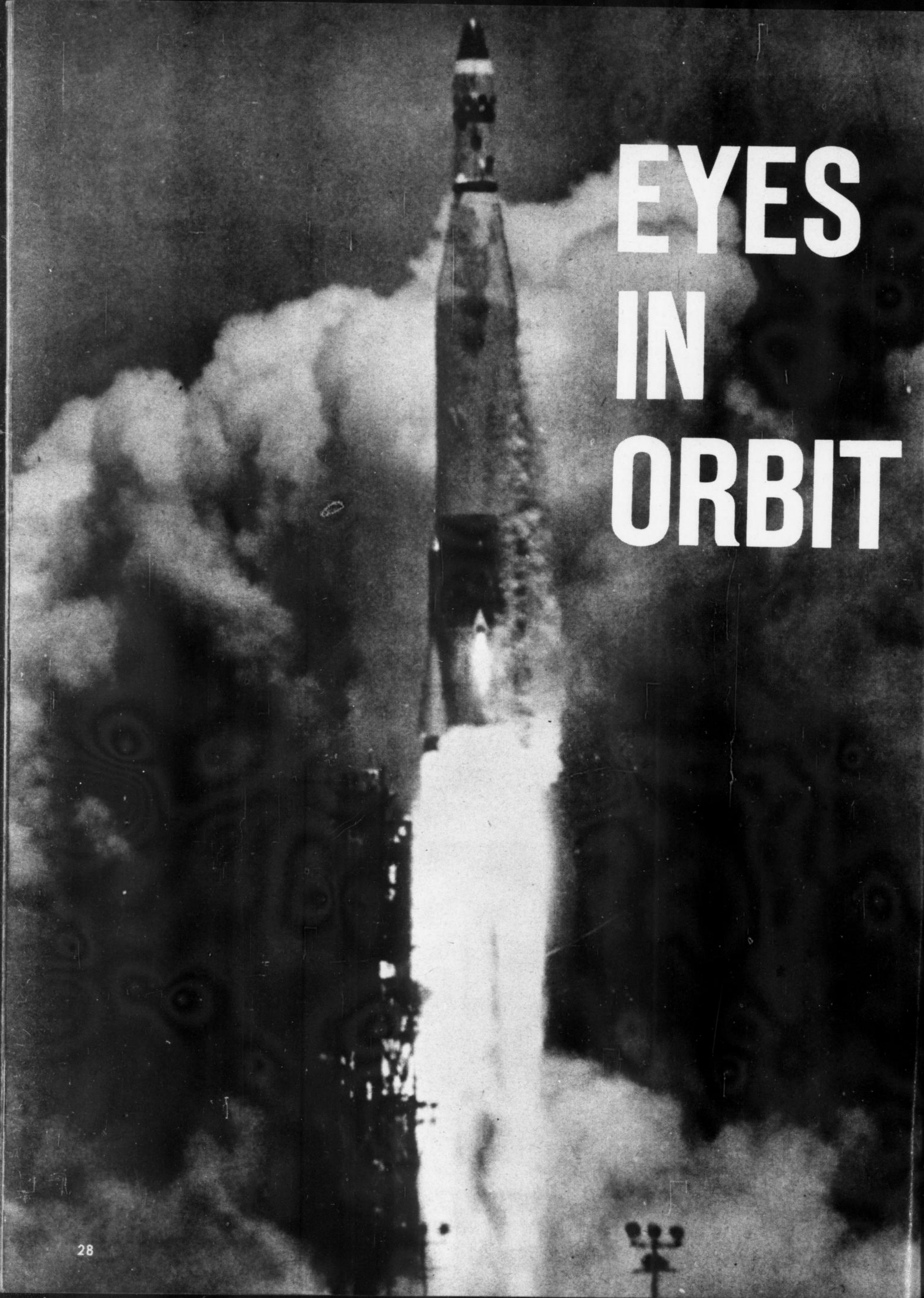


ABOVE. Initial exploration of Venus might be made by helicopters, the author says, since this planet has an atmosphere which will permit aerodynamic flight. Surface vehicles may be used later, when we discover exact nature of the Venusian landscape.

LEFT. Locomotion on moon will have to be made in airtight machines because of the thin lunar atmosphere. In this illustration, two men move an inflatable capsule by using treadmill principle. Light gravity makes this method of travel feasible.

RIGHT. Mars' dust deserts are principal obstacle to travel on the Red Planet. The author offers several alternative methods of traversing the difficult Martian terrain, including his own design of an airtight cylinder supported by five wheels.





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A full report on America's newest 'spy' satellites

by RALPH TENNER

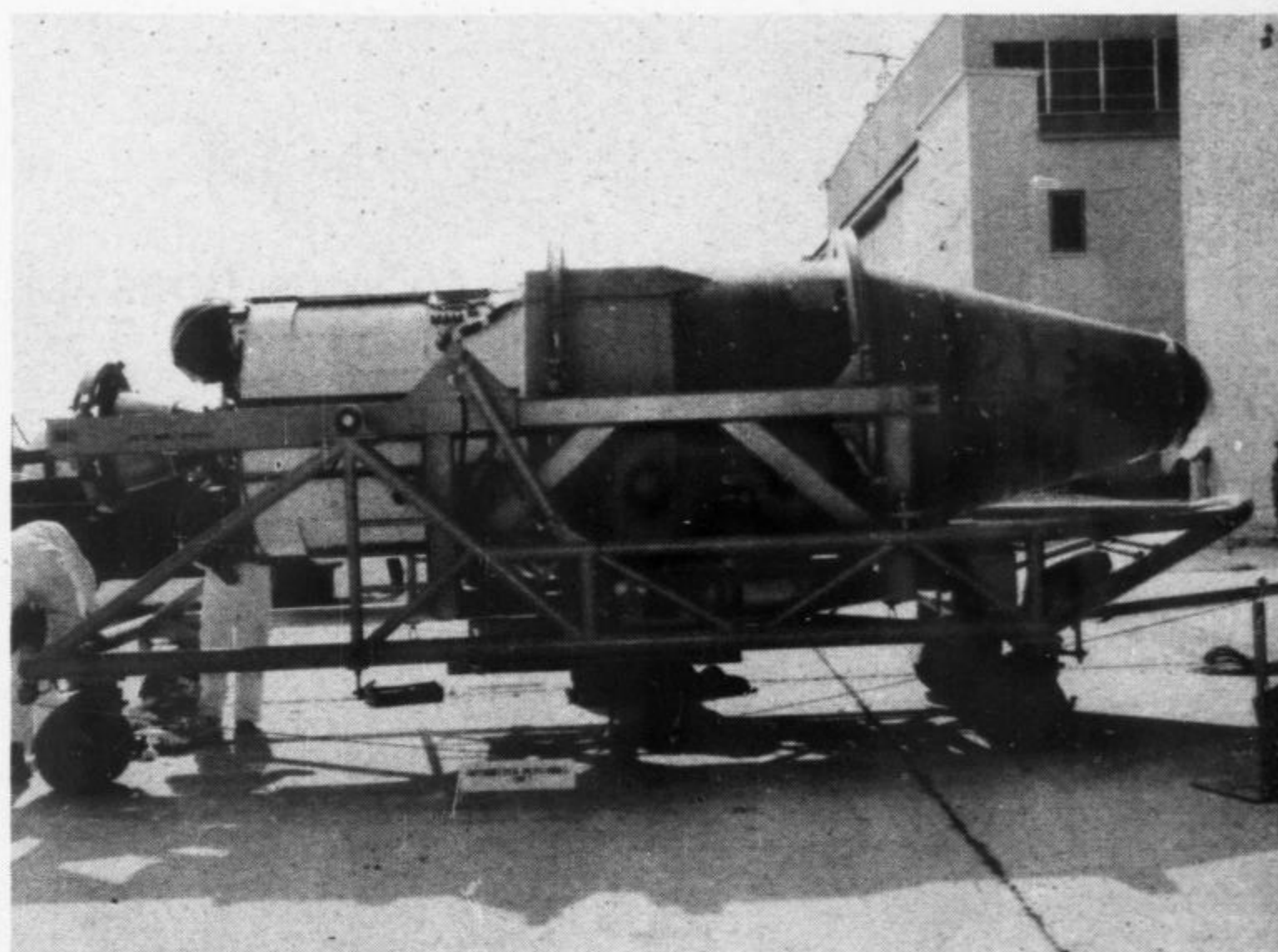
The "Space Spy" race is on.

The opening gun sounded at 12:37 P.M. on May 24, 1960 when a Convair Atlas booster thundered into space. It passed the 19-mile top altitude range of the notorious U-2 jet in less than 30 seconds.

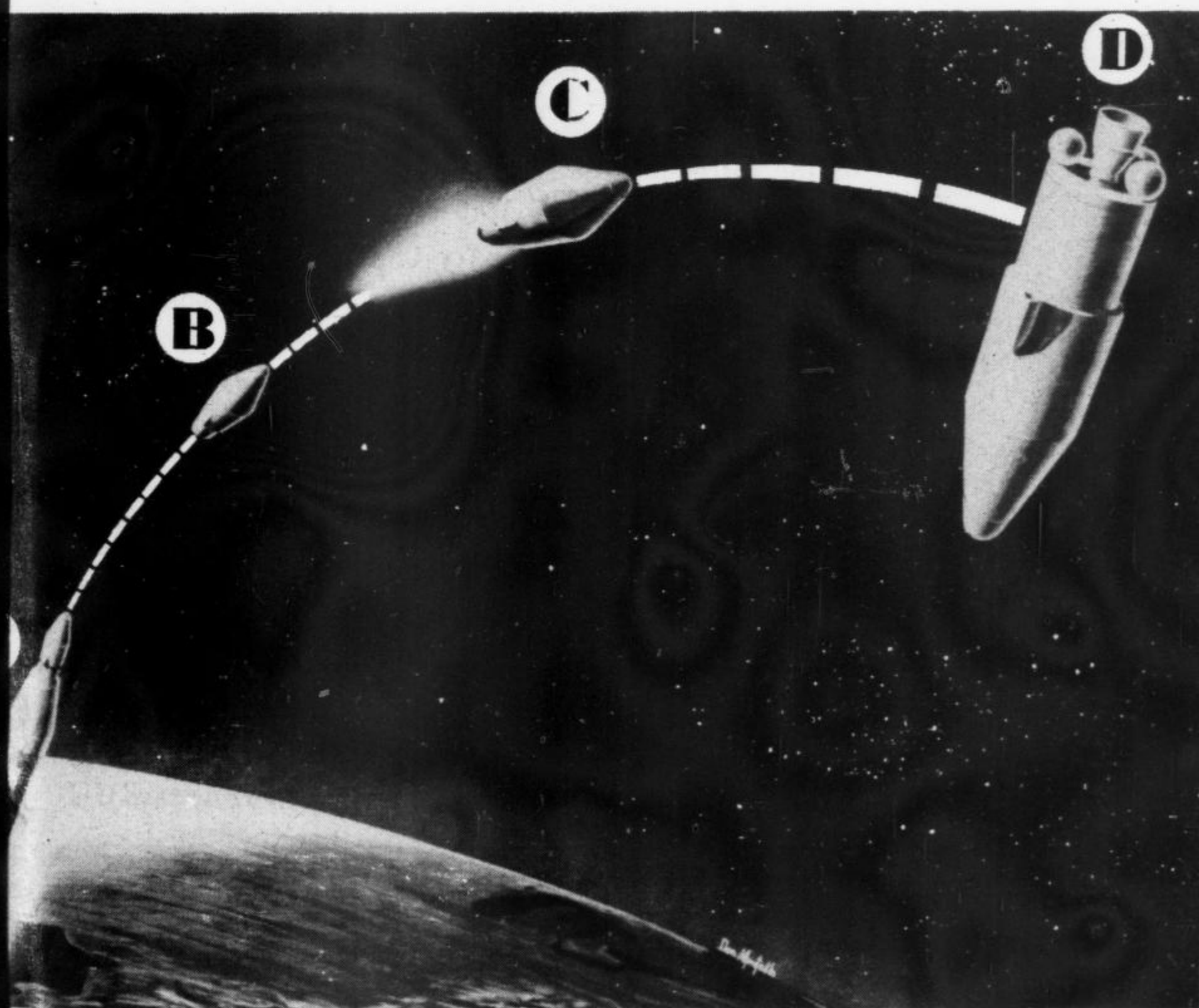
Its second stage Lockheed Agena-A ignited and rammed itself into orbit at a speed of 17,045 MPH. Then silently, each 94.34 minutes, it circled the world. Within its 4,800-pound hulk, which is 22 feet long and 5 feet wide, reposed 3,000 pounds of instrumentation, the largest USA payload ever lofted, by far. Besides the usual power-supply, radio-telemetry link and the like, it held two special devices.

One was a horizon-scanner whose spinning servo-gyroscopes kept the giant cylindrical object pointing straight down. Out of its nose poked the second new instrument—an infra-red heat sensor. The Midas II (missile defense alarm satellite) was ready for business.

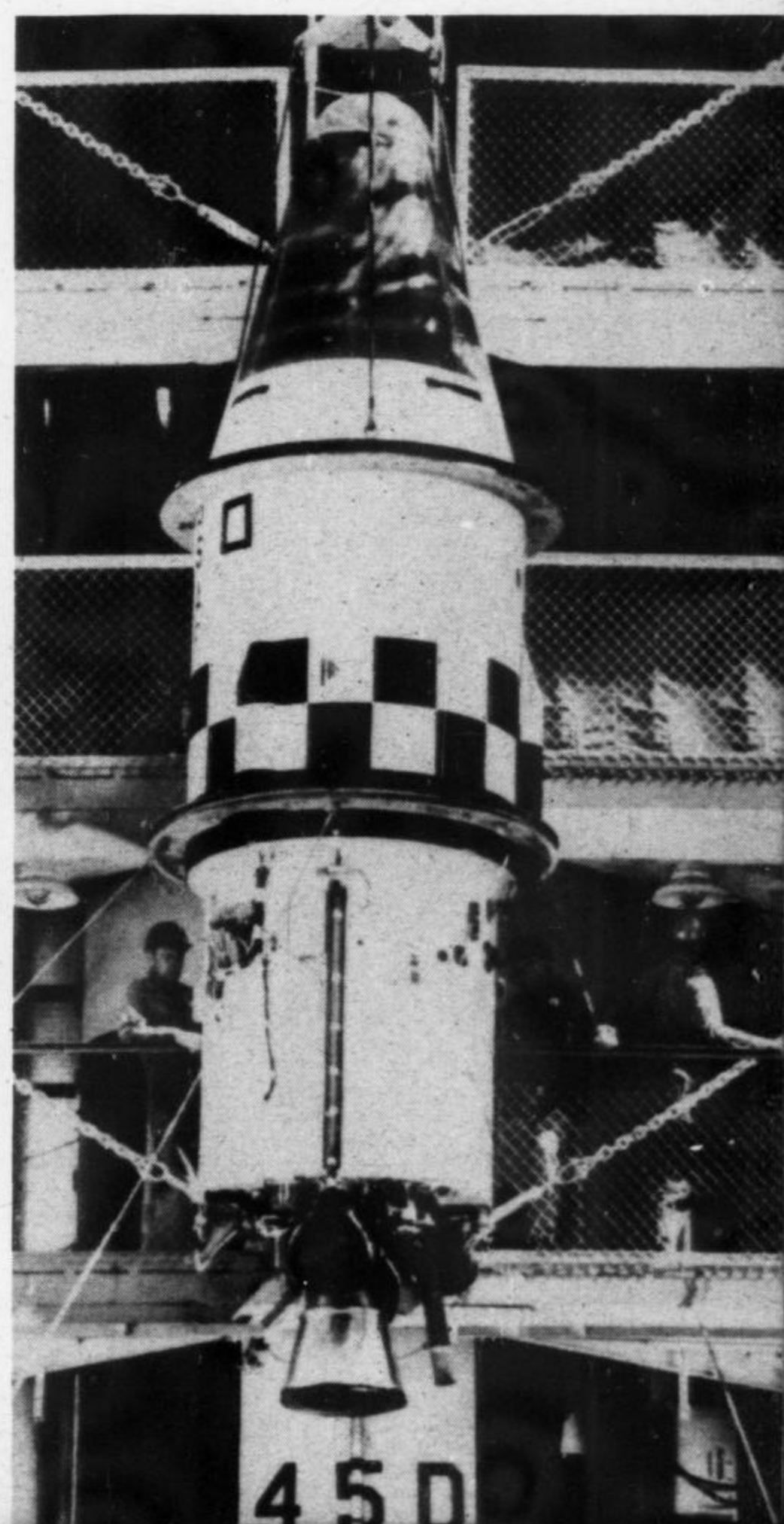
America put the Lockheed Midas II reconnaissance
(continued on page 61)



AGENA. Air Force technicians checkout liquid-propelled AGENA, with MIDAS instrument package in its nosecone. As final stage of booster, AGENA orbits at 17,000+ MPH.



ORBIT. Above, drawing shows launch and flight of Midas II. At A, Atlas leaves Cape Canaveral. B shows coasting phase of missile. At C, the satellite's integral engine ignites to power AGENA to necessary speed and altitude. D shows MIDAS in nose-down position, ready to function. At right, workmen hoist AGENA to top of gantry to be mated with Atlas booster.



After Saturn—WHAT?

In the near future, we will see the giant spaceships that will dwarf today's boosters and open the era of interplanetary travel

by EDWARD REISEN

In many respects, the development of rocketry appears to parallel the history of ocean-going vessels.

One hundred years ago, the undisputed Queen of the seas was the billow-sailed Yankee Clipper. Weighing in at 1,500 tons, these highly-refined sailing vessels utilized wind-power with unprecedented efficiency. But even as the proud clippers roamed the world's oceans, the first clumsy steamships appeared. With their more efficient power conversion, the smoke-belching coalburners soon replaced the graceful clippers.

With steam, tonnage and freight capacity were increased precipitously. But the coalburning steamers were soon superseded by still another technical advance—the steam turbine. The more efficient power conversion of the oil-burning turbine doomed the steamer, also, to obsolescence.

Today, a new power source—nuclear energy—is beginning to replace the steam turbine!

In the short span of 100 years, ocean vessels have undergone three revolutionary changes. Each step represented a brilliant advance over its predecessor and a corresponding improvement in performance.

Gross Weight/Payload Ratio

Developments in rocketry have been even more dramatic. Less than fifteen years ago, America's 9,500-pound Viking rocket made its first tentative flights into the fringes of space. Even if it were powerful enough to orbit a satellite, the Viking would have required 2,000 pounds of total vehicle weight to loft one pound of payload into orbit. By February 1959, when Vanguard II was launched, this ratio was cut in half. Vanguard III improved this performance still further and used only 450 pounds of total vehicle weight to orbit one pound.

Now, Saturn, which is currently undergoing final static firing tests, will improve this gross weight/payload (G/L) ratio still further and is expected to orbit payloads at a ratio of 25 to 1.

This improvement in rocket efficiency and performance



ARCTURUS. A modified Nova using only two F-1 engines, this giant configuration could be operational before 1965-66.



ANTARES. Utilizing a novel sled-launching ramp, this nuclear-powered vehicle will be able to loft more than 2,500 tons into orbit.

is roughly equivalent to the improvement of today's modern steam-turbine powered ships over the sail-powered vessels of a hundred years ago. But this development in rocketry occurred within the span of *only fifteen years*.

Beyond Saturn, the advances promise to be even more spectacular. Here, the parallel between rockets and ocean ships becomes significant. Extrapolating from existing scientific and engineering know-how, the space vehicles projected for the near future will approach and surpass the sheer bulk and freight capacity of today's largest boats.

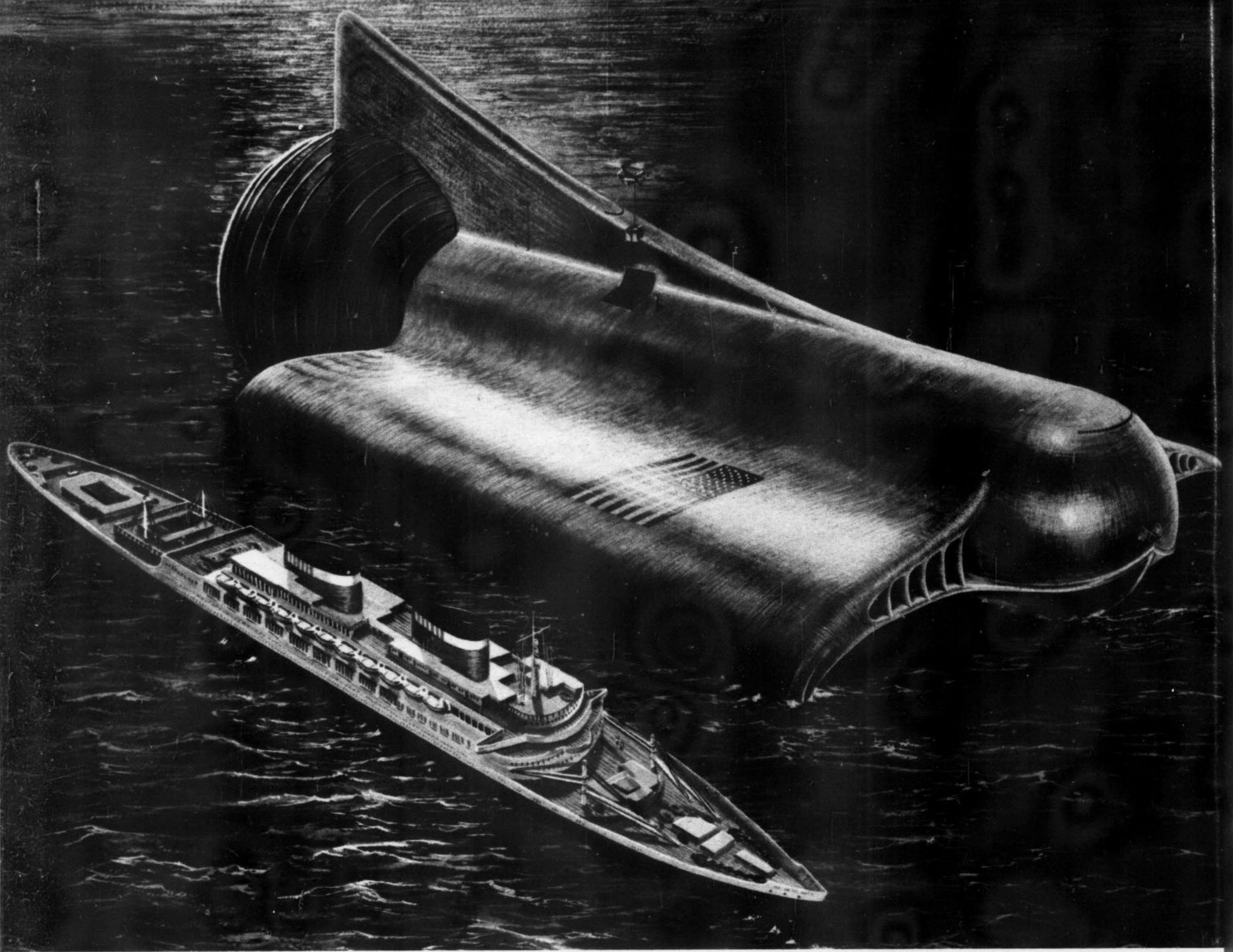
The mind staggers at the idea of a spacecraft the size of the 81,000-ton Queen Mary, but sound engineering principles are at the basis of this prediction. As size increases, there is a corresponding growth in efficiency. For example, the early V-2's had separate tankage within the airframe for fuel, whereas the outer skin of the modern Atlas and Titan also serves as the wall for the propellant tanks.

Guidance instrumentation does not increase at the same ratio as airframe size and weight. It does not take ten gyroscopes to stabilize a rocket ten times larger; one somewhat heavier gyroscope system will do the job. Cost, too, decreases with size. The early Viking, for example, weighing only 9,500 pounds, cost almost as much as today's 250,000-pound Atlas.

Nova Booster

Another significant factor in the development of large space vehicles is the comparatively modest cost per mile of space travel (as Wernher Von Braun points out in his article on page 52). Since power is needed only at launching and recovery, the total output of rocket power becomes small when computed against the vast distances that will be spanned. Explorer I, for example, which will remain in orbit for at least two more years, has already traveled well over 300 million miles. The cost per pound-

(continued on next page)



AFTER SATURN—WHAT? *continued*

ALDEBARAN. Rivaling today's largest ocean liners in size and freight capacity, the mammoth nuclear-powered rocket would be first inter-planetary spaceship.

Aldebaran could loft 30,000 tons to minimum earth orbit

per mile is considerably lower than that of the most efficient gasoline-powered engine known. Now, the rapid development of nuclear technology promises an even higher performance quotient for tomorrow's space vehicles.

Saturn represents the first big step forward in size and performance of boosters beyond ICBM capability. Weighing more than one million pounds, Saturn will have a first-stage thrust of 1.5 million pounds from its cluster of eight Jupiter-type engines. The upper stages will contain from 3 to 5 hydrogen-fueled engines, giving a combined thrust of approximately 2.5 million pounds.

While Saturn could be applied to circumlunar and lunar landing missions as soon as 1963-64, the NASA (National Aeronautics and Space Administration) has reserved the bulk of lunar exploration to the Nova

booster which is scheduled to be operational by 1967. Using a cluster of four or six high-energy propellant F-1 engines, Nova will produce a combined thrust of six to nine million pounds and will be America's first vehicle capable of manned lunar landing without orbital refueling.

Arcturus

For many reasons, use of only two F-1 engines in a modified Nova may be a more practical compromise than waiting until 1967 for the Nova with four or six engines. Dandridge M. Cole, senior advanced-planning specialist of The Martin Company, has proposed such an intermediate booster, naming it Arcturus.

According to Mr. Cole, the Arcturus could have suffi-

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cient performance to accomplish a lunar landing by 1965-66, sooner than Nova and with far fewer development problems or costs.

The booster stage of Arcturus could consist of two F-1 engines and seven Titan first-stage tank assemblies. Propellants would be liquid oxygen and kerosene, or a storable combination, developing 2,000,000 pounds of total thrust. The second stage of Arcturus could consist of three Titan tank modifications to feed a single engine of 500,000 lbs. of thrust.

In a further development, designated Arcturus II, the propellants might be a high-energy combination giving considerably more power. The third stage could be a single Titan (its first stage only) with 200,000 lbs. of thrust and more, depending on whether the propellants are high-energy or conventional.

Weighing 2.4 million pounds, the Arcturus II assembly, Dr. Cole maintains, would have more than twice the payload capability of Saturn and only slightly less than Nova. This should be sufficient to carry several men to the moon (one way trip) or one man on a round trip, without refueling.

To give the Arcturus II added performance, an air-breathing booster could be developed. An auxiliary JATO (Jet-Assisted Takeoff System) could accelerate Arcturus to 4,000 feet per second. The added JATO weight of about 1.2 million pounds would increase the Arcturus gross to 3.6 million pounds, yet payload capacity would be substantially more than Nova, whose gross weight is 4,800,000 pounds.

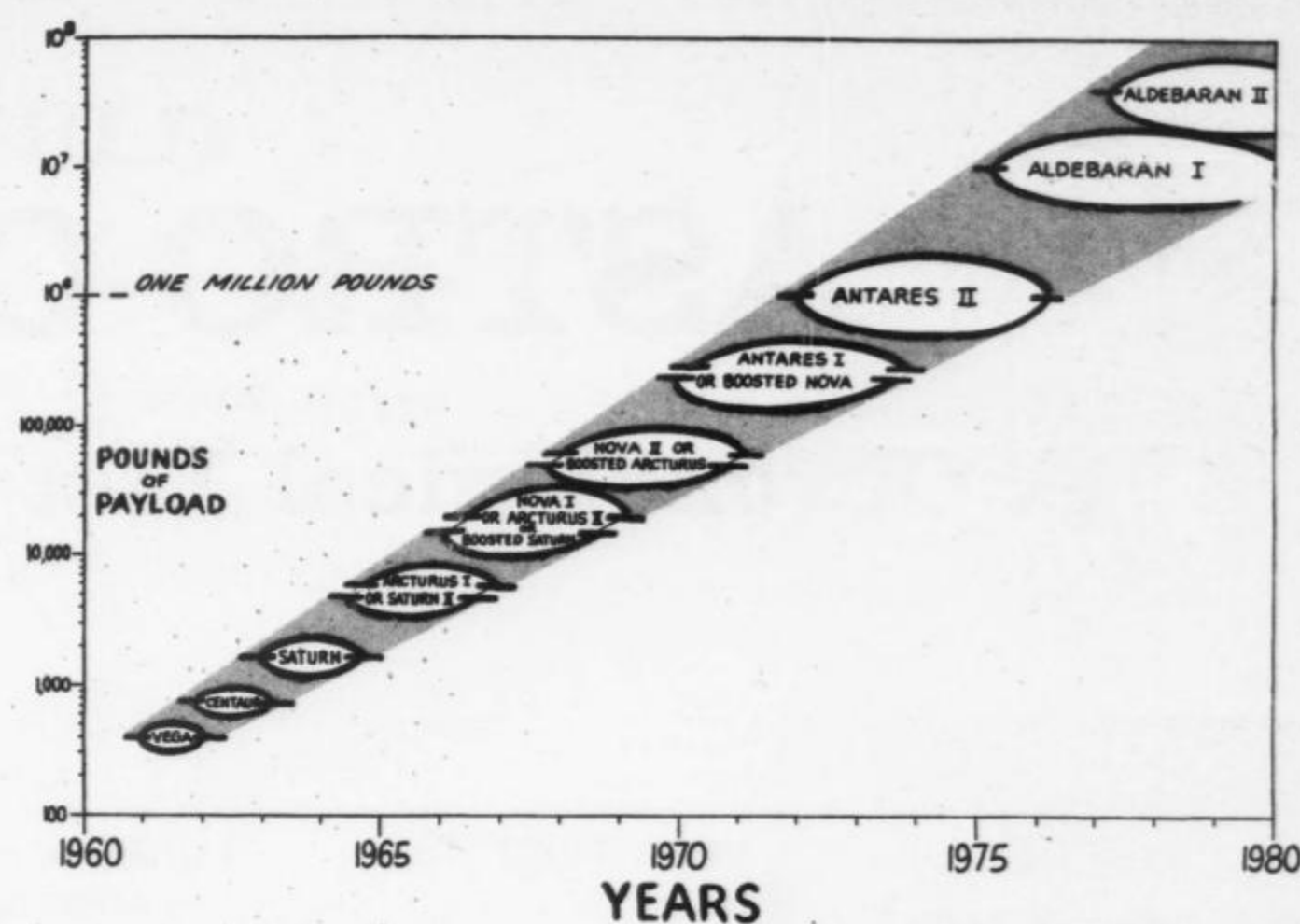
Antares

Antares is a Cole-Martin conceptual design for the next rung up the booster ladder—a nuclear space ship that could come out of the current Project Rover by the 1970-1975 period. This would be the first major operational application of the fission reactor rocket propulsion system, with a vacuum specific impulse of approximately 1,000 pound-seconds, as compared with Atlas' specific impulse of 260 pound-seconds. Specific impulse (Isp) = number of pounds of thrust per pound of fuel per second.

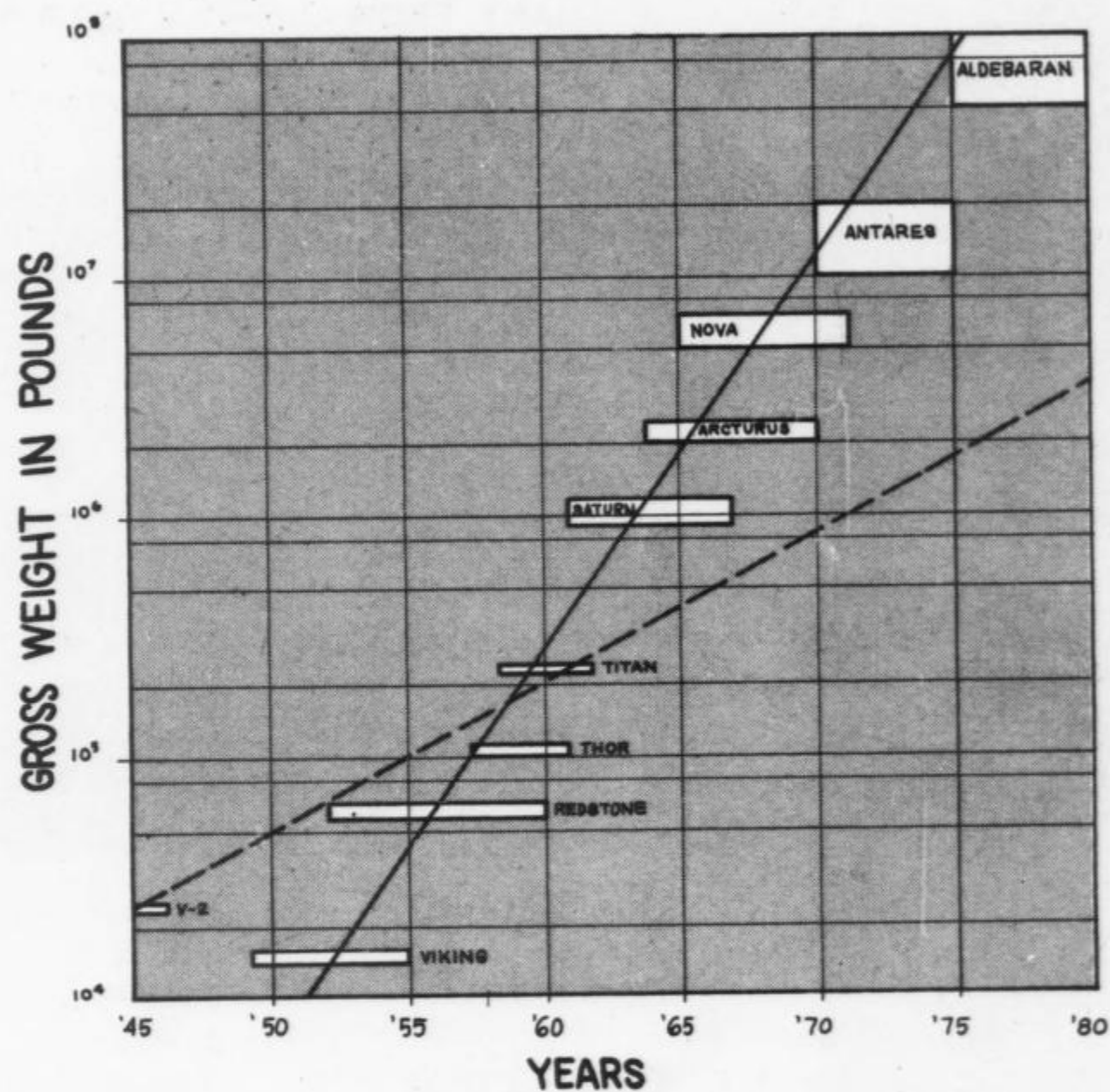
According to present theory, no nuclear rocket should be ignited on the ground as a first stage. Either its radiations on turning critical or its radioactive exhausts would contaminate the air with "fall-out". Hence, only nuclear second-stages can be planned, requiring a chemical first-stage or some alternative means of reaching open space where radiation would be harmless.

For the Antares, Cole suggests a novel device in place of the conventional first stage. The initial boost would come from an earth-captive accelerating system in the form of a turbojet-powered sled using an inclined 15-mile track. The sled carries the space vehicle to a velocity of 2000 feet per second by accelerating at approximately one g along its upward-slanting track. Then, the ramjet engines of the Antares itself take over and boost the vehicle to a speed of approximately 10,000 feet per second. Finally, the nuclear engine ignites at high altitudes

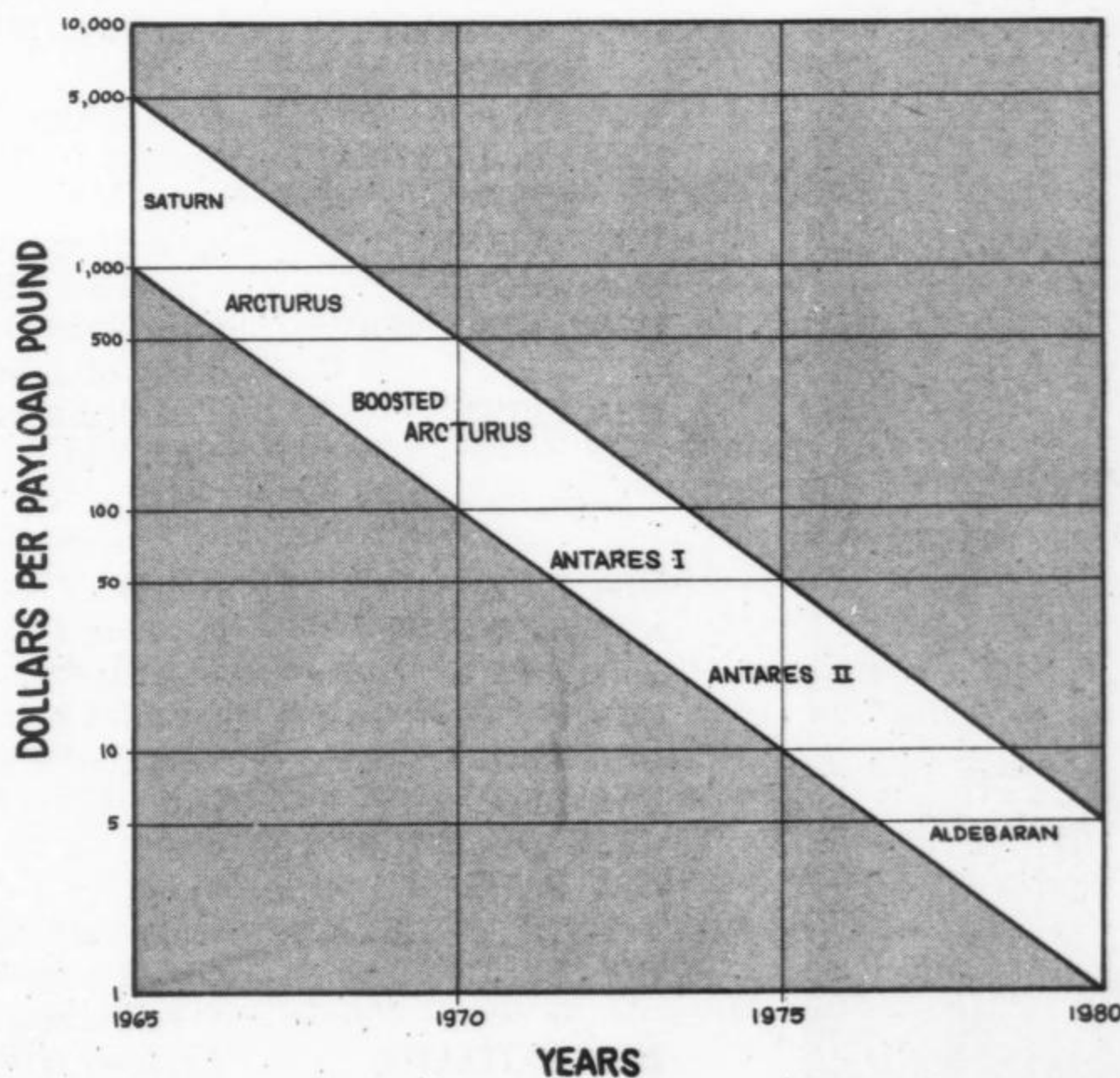
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SOFT LANDING. These payloads could be soft-landed on moon.



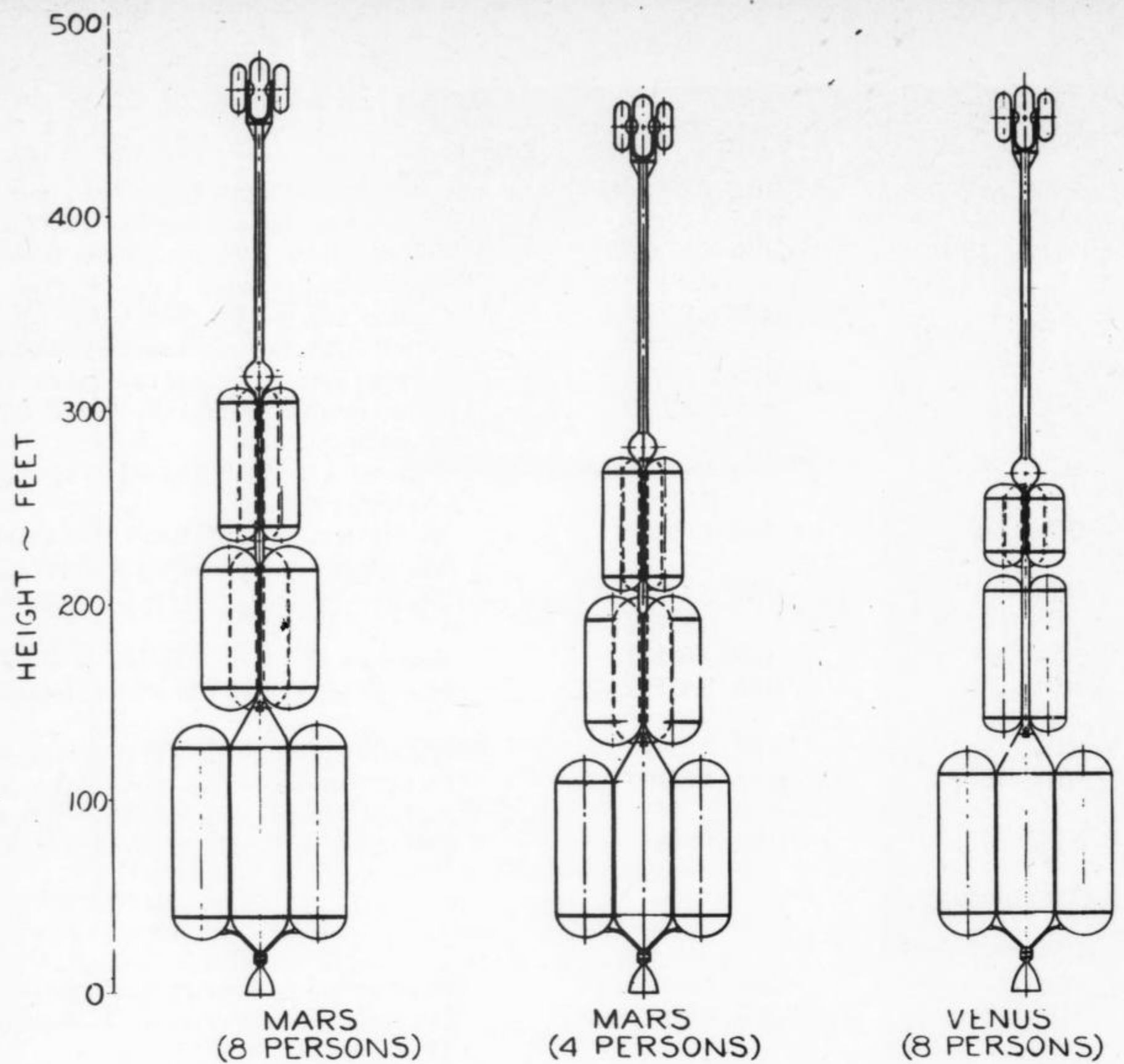
GROSS WEIGHT. Chart shows dramatic growth in rocket vehicles.



COSTS. Larger boosters mean lower earth-moon transit costs.



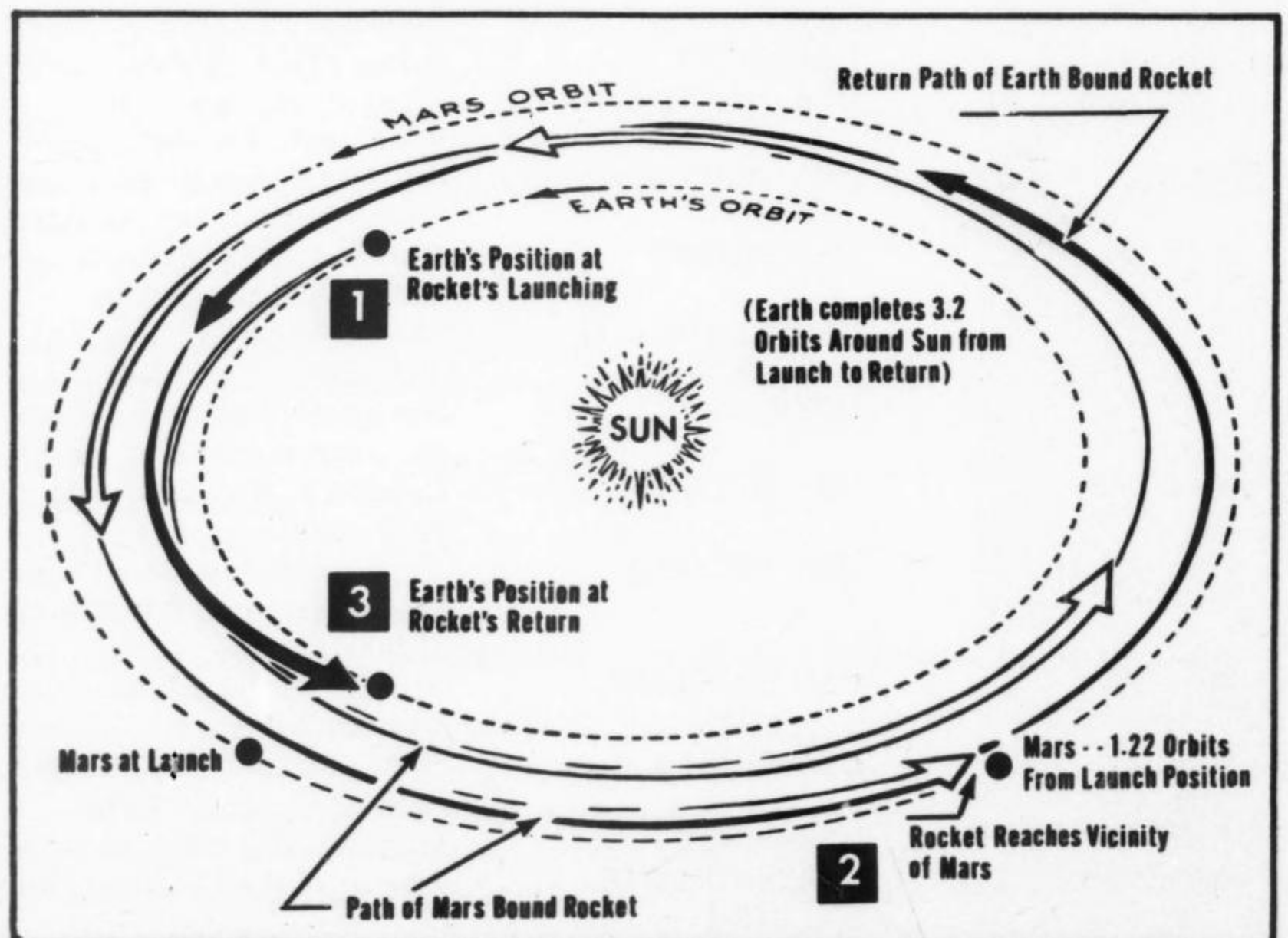
NUCLEAR POWER. Living quarters trail power source, as safety step.



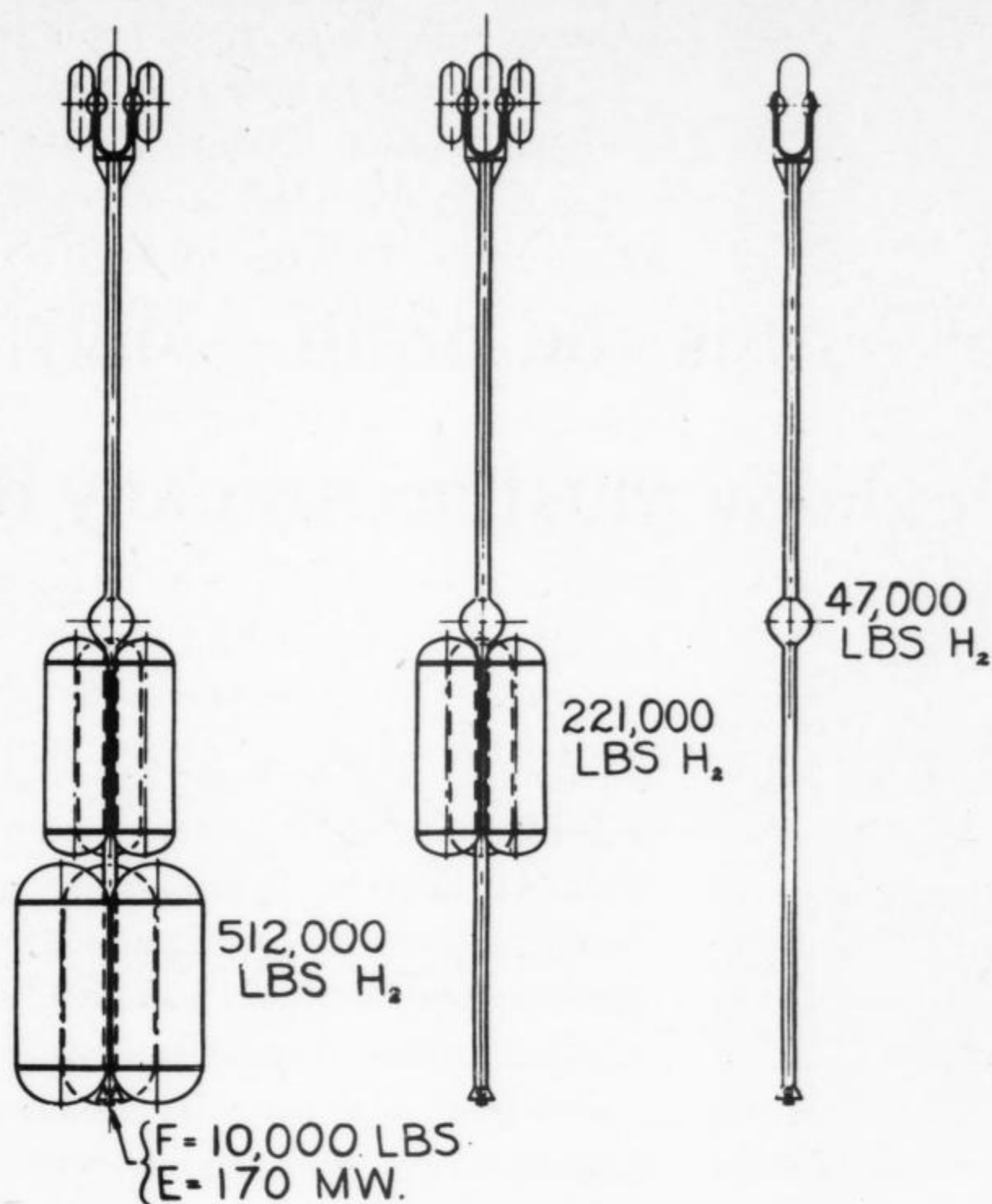
INTERPLANETARY VEHICLES. Estimated configuration for manned probes.

Interplanetary F

A SYSTEMS ANALYSIS



MARS PROBE. This chart shows positions and mission time schedule.



ARRIVE
MARS

LEAVE
MARS

ARRIVE
EARTH

RETURN. Size requirements for Mars round-trip.

y Flight:

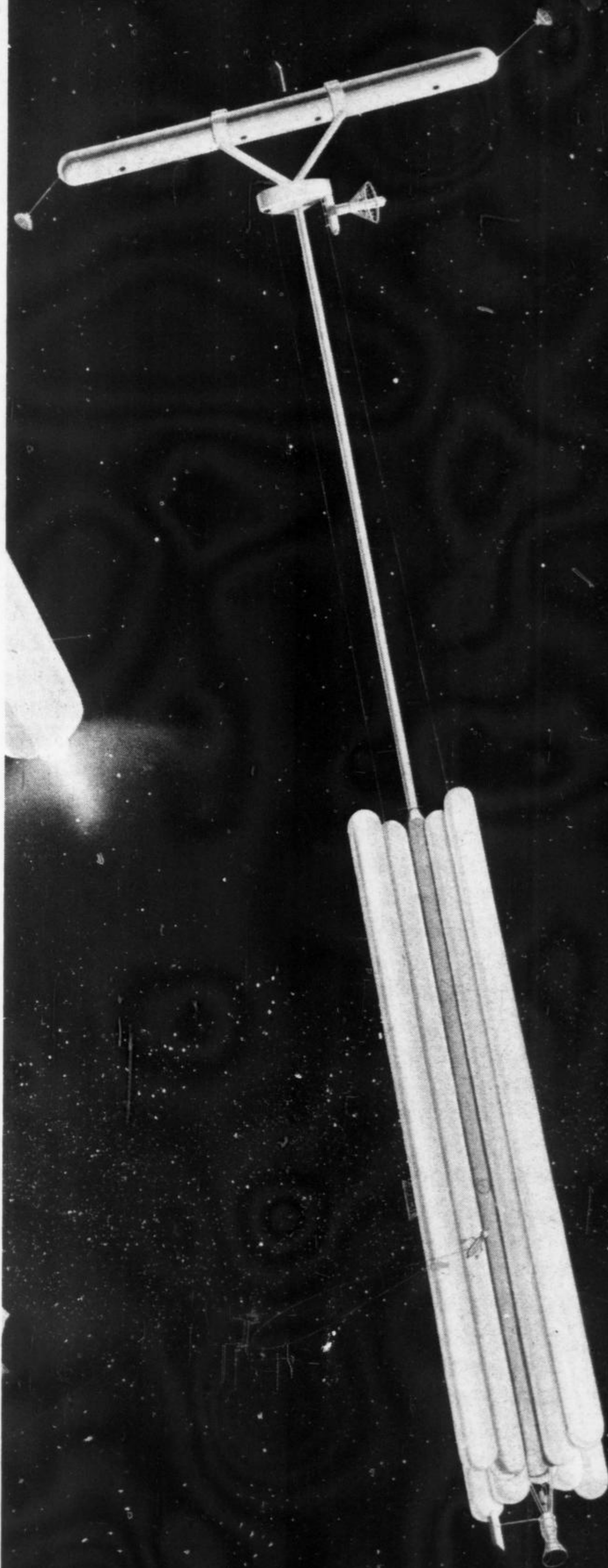
by KRAFFT EHRLICHE

Beginning this year, instrumented probes will swarm into interplanetary space to explore the environmental conditions in the vast regions between the planets and in their vicinity. They will prepare the way for manned interplanetary ventures.

In this article, the years 1970/1973 are assumed as the target period for the first manned Venus and Mars flights. By that time considerable experience will have been gained from manned lunar operations (1965-1970), nuclear heat-exchanger engines will have been developed (1959-1965) and operated in space (1965-1970). Long-term orbital flight testing of crews, plus their life support system and other vital components, will have been conducted in satellite facilities (1963-1970) and nuclear energy will have become available for many purposes ranging from auxiliary power supply to low-thrust nuclear-electric drives.

The primary objectives of the first manned flight to Venus and Mars are as follows:

1. To demonstrate the feasibility of manned interplan-
- (continued on next page)



EXOTIC FUEL. Configuration of chemical-powered rocket provides living space in nose.

Ehricke: 'The vital human payload is the brain — only 3 pounds. But, unfortunately, the body must accompany it!'

etary operations, of human adaptability and of vehicular capability and reliability.

2. To conduct, via circumplanetary orbits, detailed reconnaissance of the planet's surface and its atmosphere, as well as the electromagnetic conditions in planetary space along the way.

The first flights are to be planetary reconnaissance missions paving the way for subsequent landings on Mars and on Venus. The pioneer mission plan involves the following steps:

A. *Establishment of a satellite orbit around the target planet.* The orbital distance will be determined by conditions in circumplanetary space as previously reported by probes. For example, Venus may be surrounded by an even more intense radiation belt than Earth, because of greater proximity to the sun. Obviously, one would aim for a capture orbit either inside or outside the radiation belt.

B. *Planetary reconnaissance.* In the case of Mars, detailed surface observation in infrared, visible, and ultraviolet light will be conducted. Planetary reconnaissance will include high-resolution pictures and temperature measurements of the entire surface and atmosphere. Instrumented landing probes will be sent down, some equipped for return to the interplanetary spacecraft.

In the case of Venus, surface exploration must rely on TV-carrying probes, and on high-altitude radar reconnaissance because of the cloudy air. The interorbital spacecraft in a high orbit (say, at 10-15 Venus radii distance) is not likely to attain, by 1970-1973, a good radar resolution of an area on Venus less than 20 to 200 miles wide. This would be adequate only for major surface features of continental or subcon-

tinental dimensions, mountain ranges, etc. In order to increase the radar resolution to include smaller details, it is necessary to provide a low altitude satelloid, capable of descending into the outer layers of the atmosphere some 60 to 100 miles above Venus. The satelloid retains its orbital velocity against air drag by means of low-thrust sustainer engines. After a prescribed number of revolutions it returns to the interplanetary spacecraft or, if nonmanned, is abandoned.

C. *Return to earth* after a planetary capture period, which is as short as possible, commensurate with the reconnaissance mission.

Landing Operations

Mars is probably the most easily accessible planet in the entire solar system. Its gravitational attraction is only one third that of earth, its atmosphere is thin and calm due to the greater distance from the sun. It contains little oxygen, thereby greatly reducing rusting or decay problems of materials and food. Therefore, the temptation will be great to attempt a landing during the first flight.

There can be no arguments against the many scientific and exploratory motivations for a manned landing on Mars. However, on the first mission, a number of practical considerations advise *against* it.

A Mars expedition involving manned landing operations will require at least twice the already considerable payload weight (100,000-150,000 pounds) of an interorbital reconnaissance ship. It will require a proportionally greater weight fraction for safety and rescue provisions. It will require interorbital maneuvering capability and finally, if

the landing is to be worth the effort, it will require a much longer mission period. All these requirements are much better satisfied by a nuclear electrical spacecraft which would make it a "slow mission" rather than a "fast" one.

Practical experience in previous explorations by mankind on earth has shown that attempting to accomplish too much during the first try tends to endanger the success of the entire endeavor, holding up progress rather than accelerating it. It is therefore concluded that landing operations should *not* be included in the first mission to Mars.

A flight mission via Hohmann transfer ellipses to Mars and back involves two trip periods of about 259 days each and a waiting time at Mars (for the correct return situation) of 455 days. For Venus the trip periods are 146 days each, the waiting (capture) period is 468 days. The total mission periods are therefore about 2.7 and 2 years, respectively.

"Fast" Missions

A reduction in mission period can be attained only by using different transfer orbits to and from the target planet. These trajectories have been worked out to make possible "fast" missions. Reducing the mission period for the first Venus and Mars reconnaissance flights to values between 0.8 and 1.6 years brings the following important advantages:

1. Reduction of the physiological and psychological stress to which the crew will be subjected during the mission.
2. Considerable alleviation of the demands on the durability and reliability of vehicle and equipment.

3. Reduced crew exposure to radiation of cosmic or solar origin.

Having established the velocity requirements for fast reconnaissance missions to Venus and Mars as being in the range of 60,000 to 90,000 ft/sec (11.2 to 17 miles per second) it becomes necessary to evaluate the available propulsion systems. Nuclear heat-exchanger drives will, 10 years from now, yield Isp (specific impulse) values of about 850-950. And by merely raising the specific impulse from the present-day average of 400 to the higher Isp of 800, we immediately raise our flight capability to interplanetary proportions.

Human Payload

The life support system (LSS) can be divided into two basic parts, the ecological system and the supporting system.

The ecological payload contains the direct life-sustaining items — food, water, oxygen, absorber systems (odor, excess water) and the related mechanical systems. The supporting system comprises the hull of the living space, furniture and other internal equipment or installations such as air locks, astrodomes, space suits and taxicapsules (small maneuverable 1-man capsules for commuting between interorbital spacecraft which may be separated by distances up to a few miles).

Food, oxygen and water requirements, as well as odor and water absorption, have been studied for a long time. The three basic cycles are the air cycle, water cycle and waste cycle.

If the air cycle uses stored oxygen and a chemical carbon-dioxide absorber, the system is designated as the O₂-storage system. Or, it is the algae system if algae are used for O₂-regeneration from CO₂.

Closing the waste cycle would require feeding waste to the algae and using algae as food. Although using algae in various food forms appears definitely possible it is not necessary to do this for relatively short interplanetary expeditions since the weight of solid food (3 lb. man-day) is not prohibitive, compared to the total LSS weight. And the provision of specially selected food (for taste as well as low residue diet) will considerably add to the comfort, morale and efficiency of the crew.



MANNED SPACESHIP. Krafft Ehricke explains principles of manned interplanetary probes.

The alga chlorella is said to respond readily to variations in culture conditions. It was possible in experiments to vary the protein, carbohydrate and fat content almost at will. Therefore the value of the algae system as a potential food supply system must be considered seriously for *emergency* purposes.

Of significance is the leakage problem, since it has great consequences in terms of the gas weight which must be carried along. Assuming that even in the best hermetically sealed system, some cabin air will leak into non-aerated sections of the craft, a small extra air supply (oxygen/helium mix) must be allocated to loss.

In determining the size of the crew, it must be remembered that man is a part of the over-all system but with very special functions. He offers primary contributions — judgment, resourcefulness, memory, and perseverance, all mental qualities. His physical contributions are negligible.

The useful human payload is therefore the *brain*, about 2.5 per cent of his body weight. The latter necessarily must accompany the brain as far as we know now.

An unproportionately large mechanical weight must be carried along to serve the sustenance, comfort, protection and safety of the body—the entire life support system, redundancy, “fail safe” equipment and rescue apparatus.

With an initial LSS payload of at least 10,000 lb. per man and the average weight of the human brain of 3 lb., the ratio of useful to gross weight per man is less than 1/3000.

Under these conditions one must obviously utilize to the utmost each brain sent on the mission, while keeping the number of persons at the minimum. It is more important to provide a few indispensable persons with ample comfort, safety and rescue provisions than to involve a large crew. Modern equipment and automation take over a great deal of man's physical function in modern aircraft. The same will be true to an even larger extent in tomorrow's spacecraft.

On the other hand, the crew must be large enough to maintain a 3-phase living cycle as proposed by H. Strughold: 8-hr. work, 8-hr. rest, 8-hr. recreation. Assuming at least two persons per phase results in a minimum crew of 6 for an isolated ship. Adding a “reserve” capability of one phase yields 8 persons. If several vehicles are involved in a mission (as will most certainly be the case where propulsion systems yielding Isp under 2,000 are used) the crew can be distributed among the ships in smaller units. However, not less than 4 persons per ship, and then only if crews have means of commuting among their vehicles.

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SPACE WORLD

The news magazine of Astro-Science

JUL 1 1960

SENATOR STUART SYMINGTON

T. Keith Glennan

Willy Ley

O. O. Binder



AMATEUR ROCKETRY: Good or Bad?

YOUR AIR FORCE SPACE CAREER

SEPTEMBER 1960

VOL. 1 — No. 3

SPACE WORLD

CONTENTS

ABOUT THE COVER

SPACE WORLD
The news magazine of Astro-Science



Our cover, left to right: Minuteman; Jupiter; Snark; Polaris; Titan; and Thor; reproduced with the aid of the Torrington Company and Remsen Advertising Company.

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ARTICLES

- 8 **WHERE DO WE GO FROM HERE?,**
by Senator Stuart Symington
A Presidential candidate examines America's inadequate space program.
- 12 **ALL ABOUT FUELS,** by Ernest Haussman
Liquid, solid and nuclear, here are their roles in today's missiles.
- 14 **THE FLIGHT OF THE X-15,** by Myron Gubitz
An on-the-spot account of the flight of our first manned rocketship.
- 18 **AMERICA WON'T BE SECOND BEST,** by T. Keith Glennan
The director of the NASA blueprints the steps that will put us ahead.
- 20 **ATLAS WELDER,** by John Rublowsky
A closeup of one of the men whose work helps our Atlas missiles soar.
- 24 **MYSTERIES OF THE SOLAR SYSTEM,** by Willy Ley
Here are a few of the mysteries the satellites will soon be solving.
- 26 **AMATEUR ROCKETRY: GOOD OR BAD?,** by Ralph Tenner
Some authorities discuss their views on this controversial question.
- 30 **YOUR SPACE CAREER IN THE AIR FORCE,**
by Richard Wylie
The Air Force gives space-minded young men unprecedented opportunity.
- 32 **THE AIR AROUND US,** by Otto O. Binder
The editor discusses the thin blanket of air that envelops our earth.
- 36 **THE RUSSIAN TIME-TABLE,** by Robert Granville
Here is a blueprint of how the Soviet Union proposes to remain ahead.
- 40 **WHIZ KIDS OF SCIENCE,** by Frank Remsen
Some of our future scientists are making surprising contributions now.

DEPARTMENTS

- 4 **LETTERS TO THE EDITOR**
- 5 **BOOK REVIEWS**
- 6 **ORBITING AROUND**
- 34 **ROCKET BOX SCORE**
- 47 **SPACE QUIZ**

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A leading American statesman takes a penetrating look at our lagging Space Program and offers some answers to the question...

WHERE

DO WE GO



FROM HERE?

by Senator Stuart Symington

In the year 1484, a young Italian sailor named Columbus approached the King of Portugal with a plan to sail West and find a new route to the Indies. His brother tried to interest the Kings of England and France. All three monarchs rejected the idea.

Eight years later, Columbus made the same offer to the Queen of Spain; and because she undertook it, it was Spain and not the other nations which led the way to discovery and colonization of the New World. The claims established by Spain, and the wealth that poured in from the treasure houses of Mexico and Peru, changed her from a collection of little states to the preeminent power in Europe for 100 years.

This bit of history points the way to anyone who considers the course of America in the exploration of space.

For man's first ventures into space have opened up a chapter of history as vital to modern nations as the voyages of discovery were for the past. It is a grand enterprise of discovery, full of opportunities that challenge our imagination. Eventually, the exploration of space and the results of that exploration will play a major role in the life of man.

Even before that day, what happens in space will greatly influence our security and our position in the world. I do not speak just of efforts that have already been planned and projected — such as probing the moon, and orbiting a space station. I speak of the even more ambitious projects which will exert increasing influence over conditions on earth, and eventually send men far into the universe, to tap the planets' resources. *(Continued on next page)*

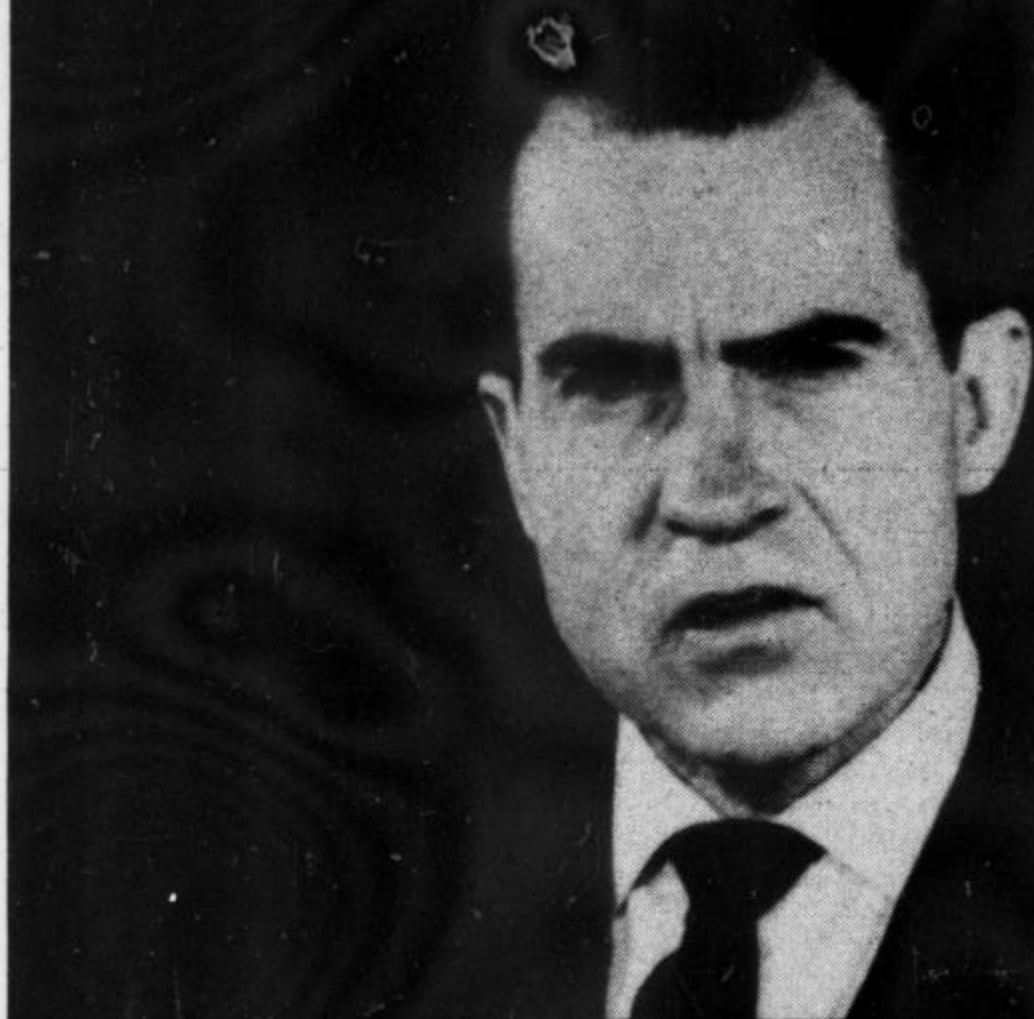
A bi-partisan look at the progress of America's Space Program to date



PRESIDENT EISENHOWER

"The primary reason for going into space, except for those activities that are carried out by the Defense Department as having some value to the security of the country, is purely scientific.

"It is best for America to work out a proper and appropriate plan of scientific exploration and follow it positively, rather than try to follow along behind somebody else."



VICE-PRESIDENT NIXON

"At the time the Russians started their space development program, we relied on the tremendous striking force of our heavy bombers which we had in great numbers. Warhead size in those days was so large, furthermore, that we did not believe it worthwhile to replace the bomber. The Soviets, however, did and concentrated on them at that time. This is the principal reason why America is now behind in the developing of large rockets."

WHERE DO WE GO FROM HERE?

continued

Of course such activities strain the imagination of many of us today. It has been estimated that a manned flight to Venus, at a minimum launching velocity of 38,000 feet per second, would take five months.

This is no longer than a trip by covered wagon took from Missouri to California in 1849, on the Santa Fe trail.

Deep space flight will pose many dangers. Some we can predict, others we cannot. But the covered wagon trips which opened up the West were fraught with many great dangers to the first pioneers.

I believe that the nation which leads the way into space, and follows up that lead, will hold in its hand the key to the future. The advantages accruing to those who first mas-

ter this new dimension are enormous — for possible war and for peace, for good or for ill. The peaceful exploration of space can create world living standards higher than earthbound men can dream of.

Think of the utility of a space vehicle that could predict weather conditions even before they occur. Through the knowledge gained from such meteorological satellites, we could eventually make giant strides toward controlling the weather. By regulating rainfall, we could eliminate the arid conditions which now chain the productivity of millions of acres in our nation, as well as in Asia and the Middle East. By regulating temperature, we could open up new areas of the earth for comfortable settlement.

Nor can we exclude the possibility, once space flight is achieved, of the discovery and colonization of other planets. In these ways, many of the basic causes of international tension — poverty, misery and hunger — could be eliminated, and with them war itself.

Now let me just mention a few of the new applications (closer to earth).

There is now in development a television reconnaissance satellite which can photograph objects seven feet in diameter, from 300 miles above the earth. The nation that can orbit such a reconnaissance vehicle obviously has an advantage in the field of intelligence.



EVERETT DIRKSEN
SENATOR

"I have faith and confidence in our Commander in Chief, President Eisenhower, and his dedication to his responsibilities. I do not think that he would allow America to lag behind Soviet Russia to a dangerous degree in either space exploration or missiles. The present administration has done all it can to keep us abreast in the space race and in military might."



HUBERT H. HUMPHREY
SENATOR

"I believe that our Space Programs need a higher priority. We are in a 'space race.' Not only are there military implications, but there are also tremendous psychological implications. We must have a comprehensive civilian-military program designed to maintain American leadership in every aspect of the space field. We must not lose this vital race."



LIVINGSTON MERCHANT
UNDERSECRETARY OF STATE

"The Soviet accomplishments in the field of missiles and space exploration are witness to the strong scientific, technical and industrial capabilities of the Russians. The danger to ourselves would not come from the recognition of these sobering facts but from the refusal to recognize them. The Department of State fully supports a strong effort."



HENRY CABOT LODGE
UN REPRESENTATIVE

"We live in an era of new challenge, of new hopes and ideas. Man has now penetrated outer space. Future historians will mark this development as one of the most important in human history. A new factor has been added to man's existence. We can use this new dimension to destroy ourselves or we can use it as a vehicle for new collaboration and harmony."

There is now in development a nuclear weapon which can first be placed in orbit, then recalled, electronically, to hit any point of the earth. Any nation orbiting such a weapon literally holds the sword of Damocles over its adversaries. And it is not outside the scope of present studies to imagine a space vehicle which could, through ground control, turn back aircraft or other space vehicles by the mere turning of a switch or pressing of a button.

Another tremendous reward for leadership in space is the impact on the minds of men. The heavens can be seen by the eyes of all men. For centuries, people have looked at them in awe. There is no more effective place to display scientific accomplishment.

Last month, the head of the United States Information Agency, George Allen, testified before Congress as follows:

"It is hardly an overstatement to say that space has become for many people the primary symbol of world leadership in all areas of science and technology. Our space program has an importance far beyond the field of the activity itself. It bears on almost every aspect of our relations with people of other countries, and another view of us as compared with Russia."

As the man in charge of America's strategy in the contest for men's minds, this is what he believes: "The see-

saw seems to have tipped solidly in the Soviet direction in world opinion" as a result of Sputnik, the moon shot, and other dramatic achievements on this great world stage.

Soviet Accomplishment

The Soviets do not intend to rest on their accomplishments so far. They intend to press their advantage in space — to play it for all it is worth. In reading Soviet scientific literature, one cannot help but be impressed by the boldness, the scope, and the dedication of the Soviet effort toward the ultimate conquest of the cosmos.

There seems to be no question in the Russian mind that man's most cherished dream will be fulfilled in and by the Soviet Union. They have already made great strides toward attaining this goal, including their large geophysical research rockets and their massive artificial Earth satellites, plus the extensive detection, tracking, and data-handling network associated with that satellite program.

Their confidence in the ultimate result is reflected in the fact that, whereas originally Sputnik observers were asked to send their tracking data to Moscow-Sputnik, they now ask that data be sent to *Moscow-Kosmos*.

In such a competition, it is essential to have a clear idea of where we are behind and where we are ahead.

(continued on page 44)

INDEXED BY PAL

ALL ABOUT FUELS

**Liquid, solid or nuclear, here
are the pros and cons
about the biggest controversy
raging among rocketmen**

BY ERNEST HAUSSMAN

AT 10:58 P.M., on January 31, 1958, that never-to-be-forgotten day, the countdown reached its climax — "... three ... two ... one ... zero." The 68½-foot Jupiter-C launch vehicle trembled on a pillar of flame. Slowly it rose from its Cape Canaveral launching pad, then gained speed as tons of liquid oxygen and Hydyne fuel (unsymmetrical dimethyl hydrazine) met in fiery embrace.

Liquid propellants hurled the first stage 60 miles up. Solid propellants, in Sergeant Rocket groupings, successively fired in the three upper stages. Together, these powerful fuels hurled Explorer I, America's first orbiter, into space.

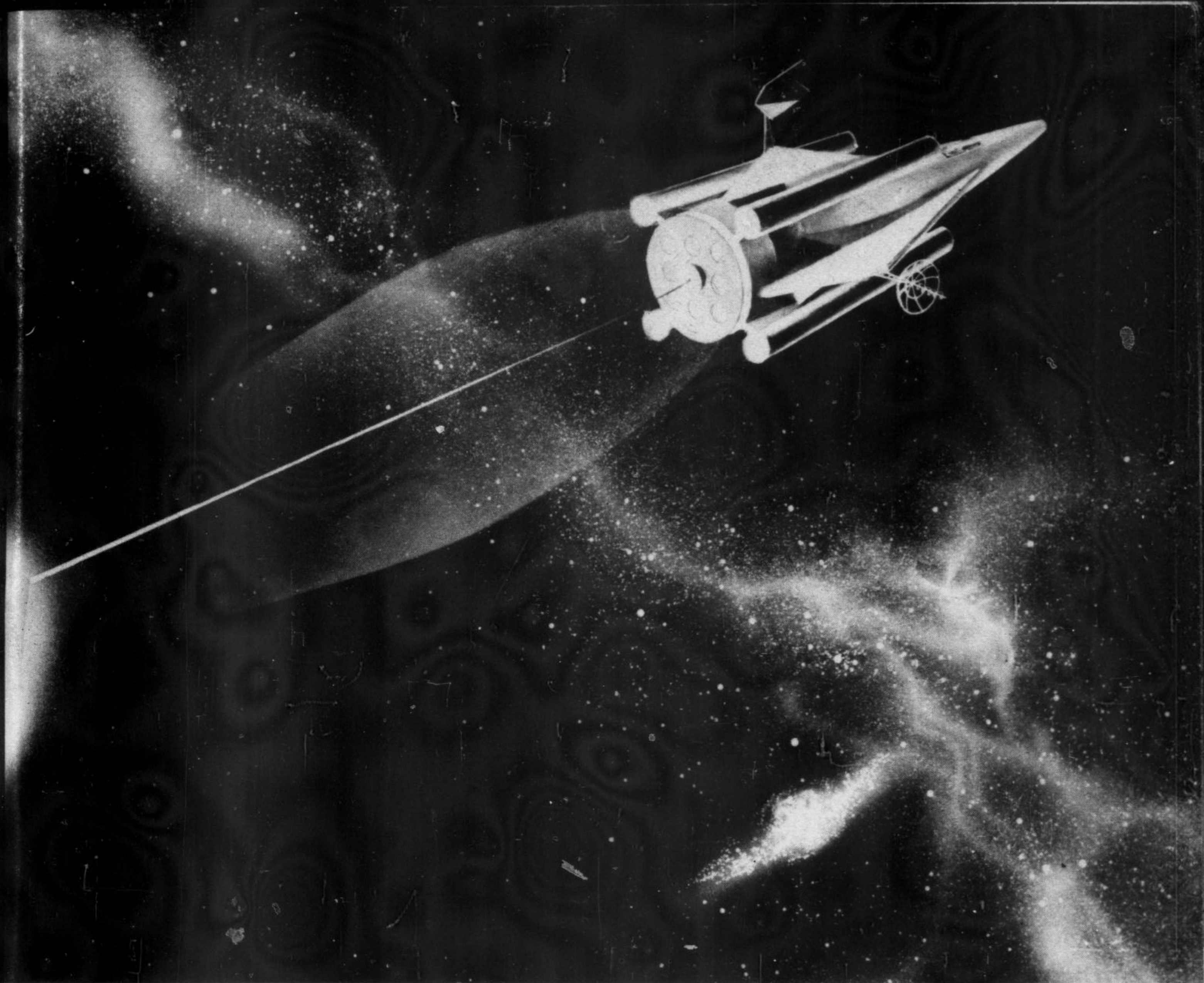
In that rocket, and many others that followed, both liquid and solid fuels were used in different stages. The tendency today is to have "pure" rockets, either all-liquid or all-solid. But to date neither species has yet "ousted" the other — and very likely won't for a long time to come, if ever.

A third contender coming up — nuclear rocket power —

will not "take over" completely either. To avoid contamination of the lower air with radioactive exhausts, future boosters using nuclear power will be a "hybrid" mating — a conventional chemical first-stage that will loft the assembly into rarefied reaches before the nuclear second-stage roars to life and finishes the boosting job for the payload. Up there, the second-stage's atomic "fall-out" will dissipate harmlessly.

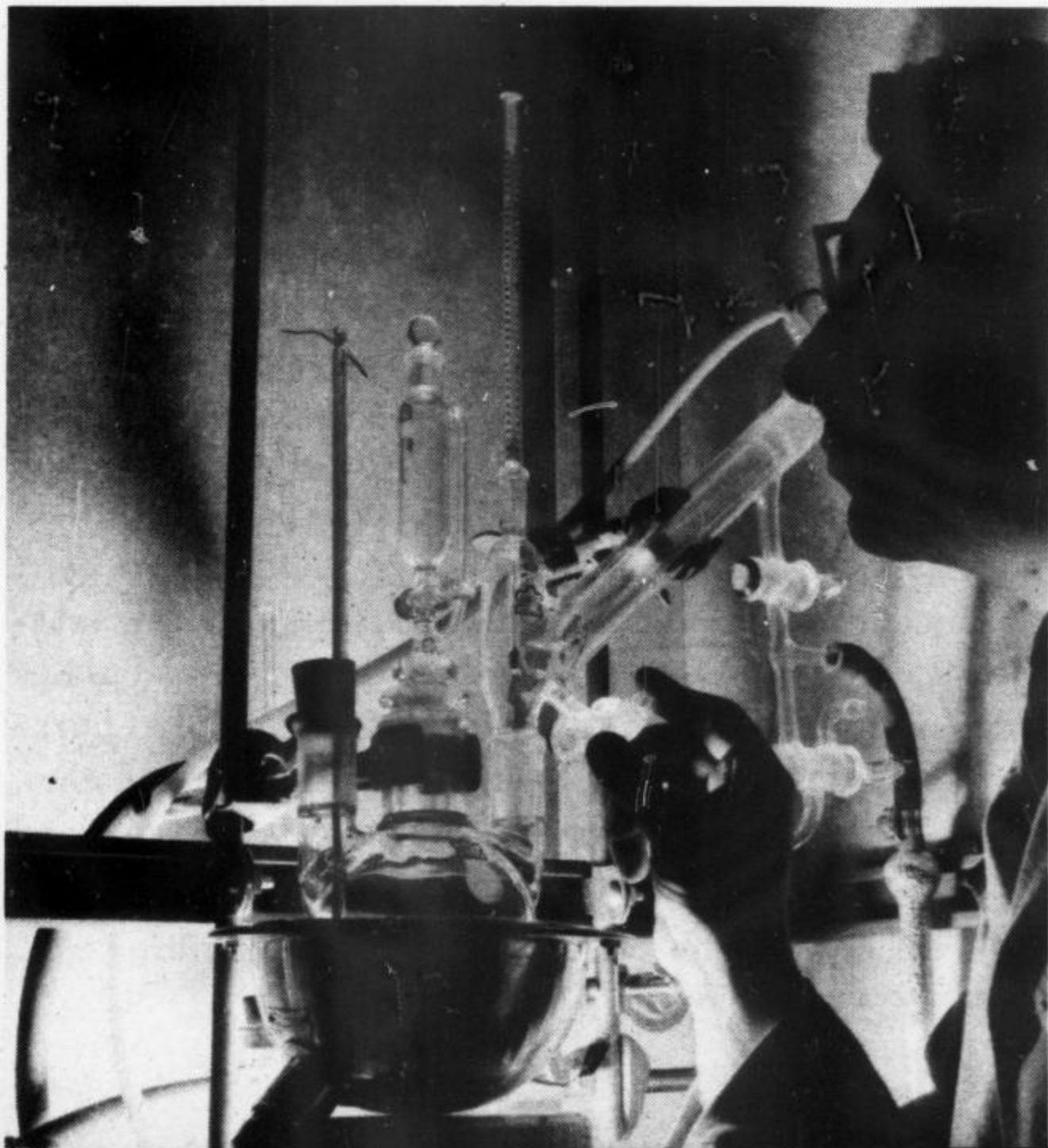
Therefore, like the simultaneous use today of coal, oil, hydroelectric dams and nuclear powerplants — all producing electricity side by side — there will always be a place for liquid-fuel, solid-fuel and nuclear-propulsion techniques, even when *more* advanced systems beyond the nuclear come into play.

True, there are certain strong liquid-fuel advocates who believe it will be the main propulsion system for long years to come. The solid-fuel school as stoutly predicts their reaction engines will be king in time. The nuclear people, just beginning to be heard, are sure their technique will take first place later on. (*continued on page 49*)



NUCLEAR POWERED ROCKET. Atomic power with its efficient conversion ratio will provide thrust for interplanetary flight.

LIQUID PROPELLANT. High thrust generated by liquid oxygen and refined fuels makes this the most favored fuel.



SOLID PROPELLANT. Compact and easy to handle, these are oldest fuels. Precision blending must be maintained.





FLIGHT OF THE X-15

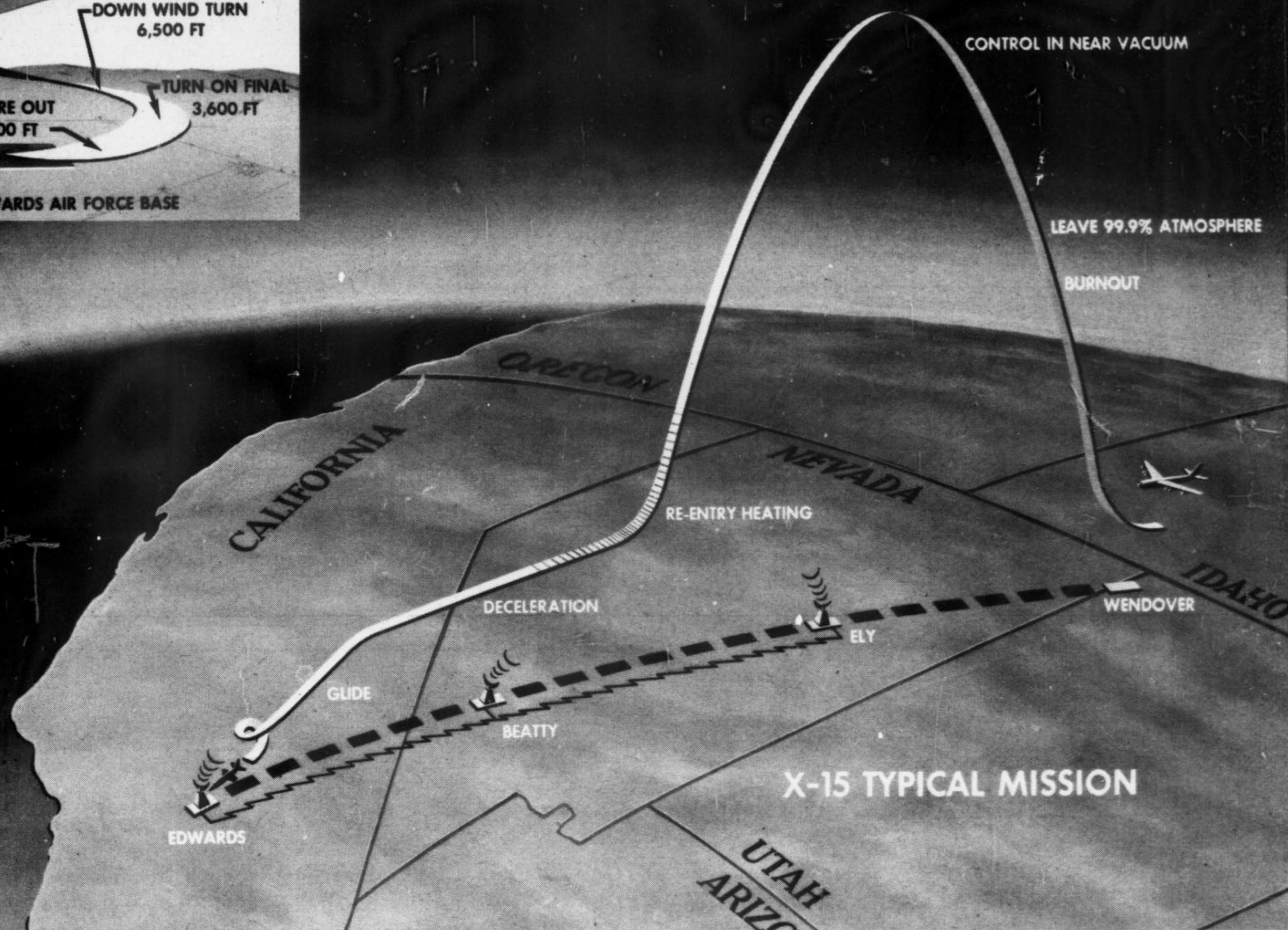
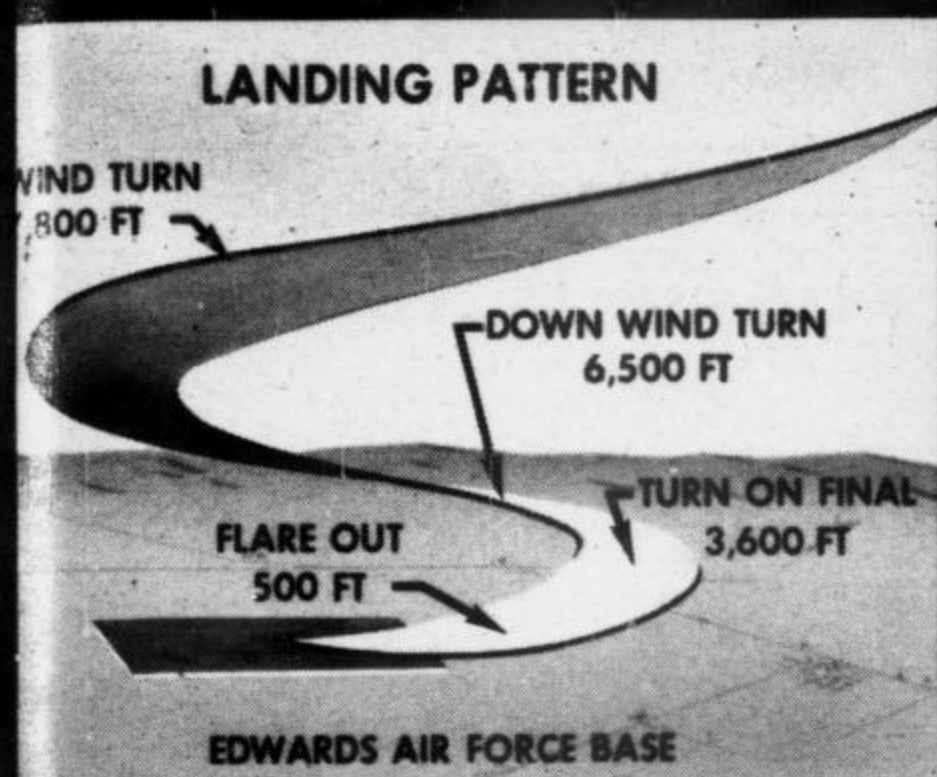
THE half-light of dawn has not yet touched this part of the vast Mojave Desert. Under the black sky pierced by millions of sharp, hard stars, the air is chill. The bleak landscape is a tumbled mass of grays and blacks. There is a deep quiet everywhere.

Suddenly the stillness is shattered by the cough of a gasoline engine. Man is here. Many men, in fact, going about their peculiar tasks, regardless of the stony indifference of their surroundings.

This is the Air Force Flight Test Center at Edwards Air Force Base, a sprawling checkerboard of shacks, homes, hangars, laboratories, roads and runways. It is a proving ground for tomorrow — a place where strange new aircraft are tested, hurtling through the desert air at many times the speed of sound and leaving thunderous “sonic booms” in their wake. Here, highly skilled and carefully

chosen men, military and civilian, participate in some of the world's most audacious adventures.

The bulk of the Edwards flightline is still sleepily quiet. But in one corner there is the hum of purposeful activity. A large area, about three hundred feet across, is roped off; security guards patrol it. In the center of this circle, bathed in the yellow glare from dozens of spotlights, is a huge B-52 jet bomber. Her tall, orange-painted vertical tail bears the number 20003. She is being tended by a procession of men and machines . . . small, yellow tank-trucks, connected to the B-52 by long hoses; ground power units, rumbling their guttural song of energy. Men hurry back and forth, some of them dressed in work clothes, others encased in cumbersome, one-piece fabric suits and helmets that give them the appearance of pale, deep-sea fish cast up on land.



FLIGHT PLAN. Map shows the projected trajectory for the X-15's historic flight to an altitude of 100 miles and higher.

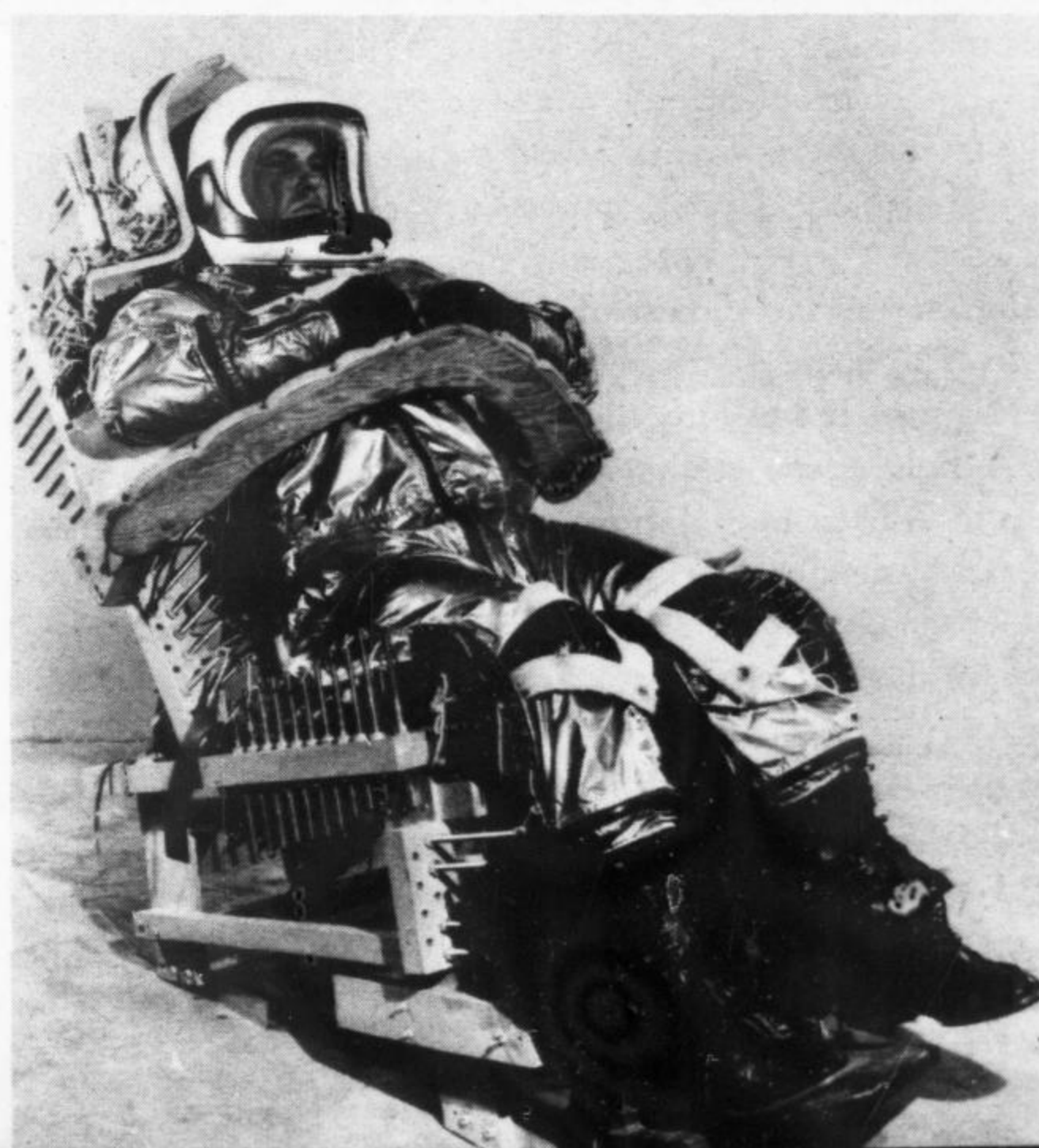
by Myron B. Gubitz

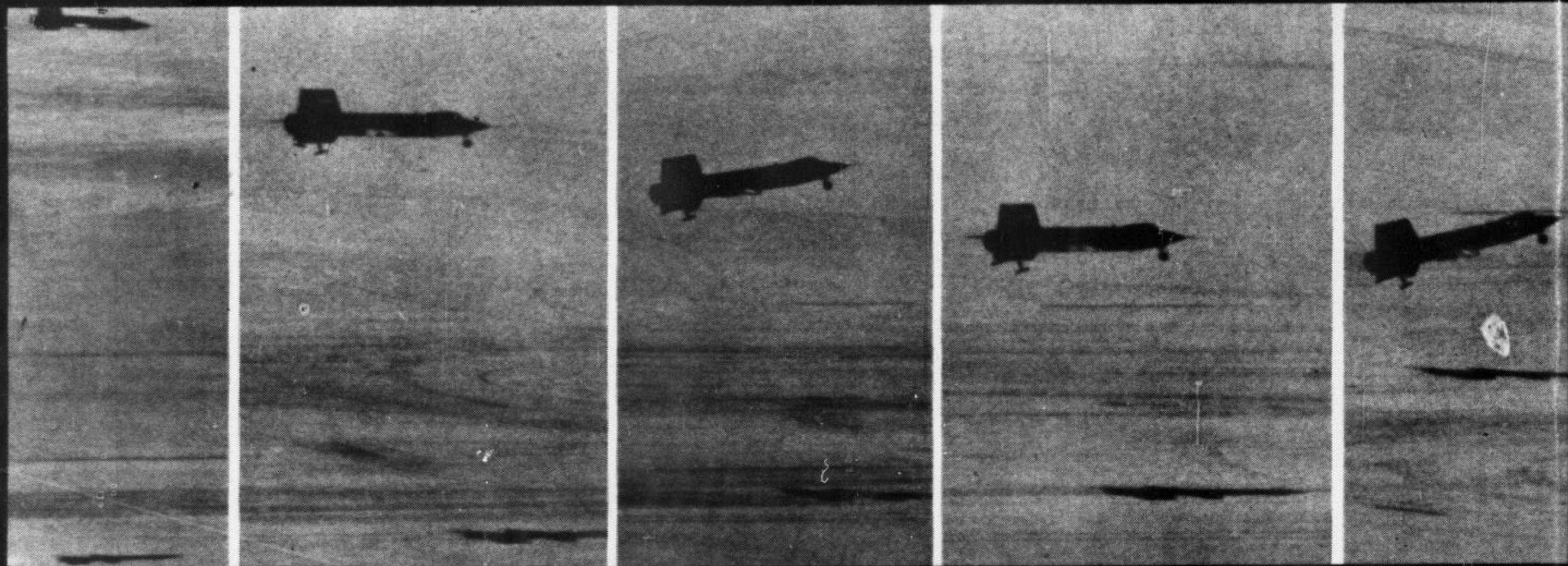
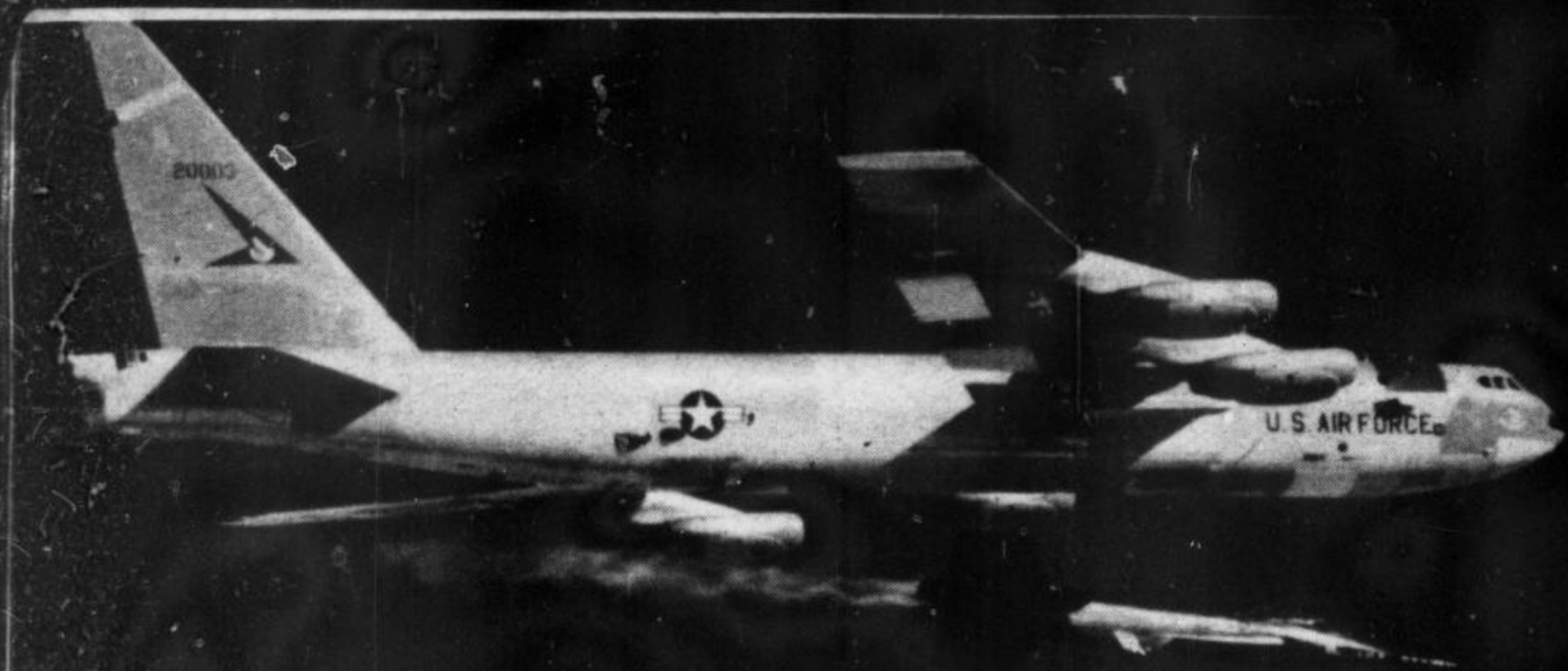
The ground around the B-52 is haloed in a strange mist, a whitish vapor swirling and rolling in the constant desert wind — water vapor that condenses upon contact with the lox being pumped into the X-15. The ground crewmen move around, shouting to one another, going over lengthy check lists to make sure they do not forget a single item needed to prepare this ponderous beast for flight.

A lightness begins to spread across the sky. Shapes separate and take on individuality. Under the right wing of the B-52, the dark shape of another airplane can be distinguished. It is an odd "bird." Hanging from a special pylon built into the underside of the bomber's right wing, it nestles there like a young, eager hawk, its every line created for speed. Its sleek, fifty-foot length is a lusterless black. Behind and above its sharp, pointed nose is a narrow protrusion bordered by thin, angled windows. Far

(Continued on next page)

PRESSURE SUIT. Pilot will be protected from effects of acceleration and low-pressure by this new MC-2 uniform.





FLIGHT OF THE X-15 continued

aft of this canopy are two stubby wings, and behind the wings a four-finned tail. At the extreme rear are two clusters of tubes jutting out of the body — rocket tubes that speak of *power*.

Up front, near where the long needle on its nose begins, are the cryptic white letters that spell this creature's name: X-15.

Outside the roped-off area where the work is progressing, trucks and cars are parked and many men mill around, talking, checking, waiting. Among those waiting are a photographer, determined to get his pictures despite the poor light; a reporter, pad and pencil in hand, trying to capture the strange mood of the scene with simple words; a few Air Force and government officials vitally interested in the success of this special project; representatives of some of the scores of manufacturers who have had a part in building the unique X-15.

A light green station wagon, bearing the insignia of North American Aviation, pulls up to the other parked cars. A slender, dark-haired man alights. Some of the other men, recognizing him, stroll over to exchange greetings with the newcomer. Soon he walks off toward a yellow van parked at one side, mounts the steps leading up to it, and enters. On the side of the van are blue letters: "16th Physiological Training Flight."

The night is over now. The sun's warmth is beginning to take the edge of chill from the morning air. The large spotlights placed around the work area are turned off.

From a loudspeaker atop a small truck comes a metallic voice: "Attention all personnel. We are now servicing the B-52 LOX top-off system. We will then be towed from here. All unnecessary personnel please clear the area. All unnecessary personnel please clear the area."

The pace of activity steps up. Three men walk purposefully across the field and climb into the bomber. Another man awaits them within it. These four are the crew of the B-52 "mother ship."

At other points on Edwards and in the surrounding desert, radar crews are turning their mysterious dials and regarding their all-seeing scopes, scanning the cloudless western skies.

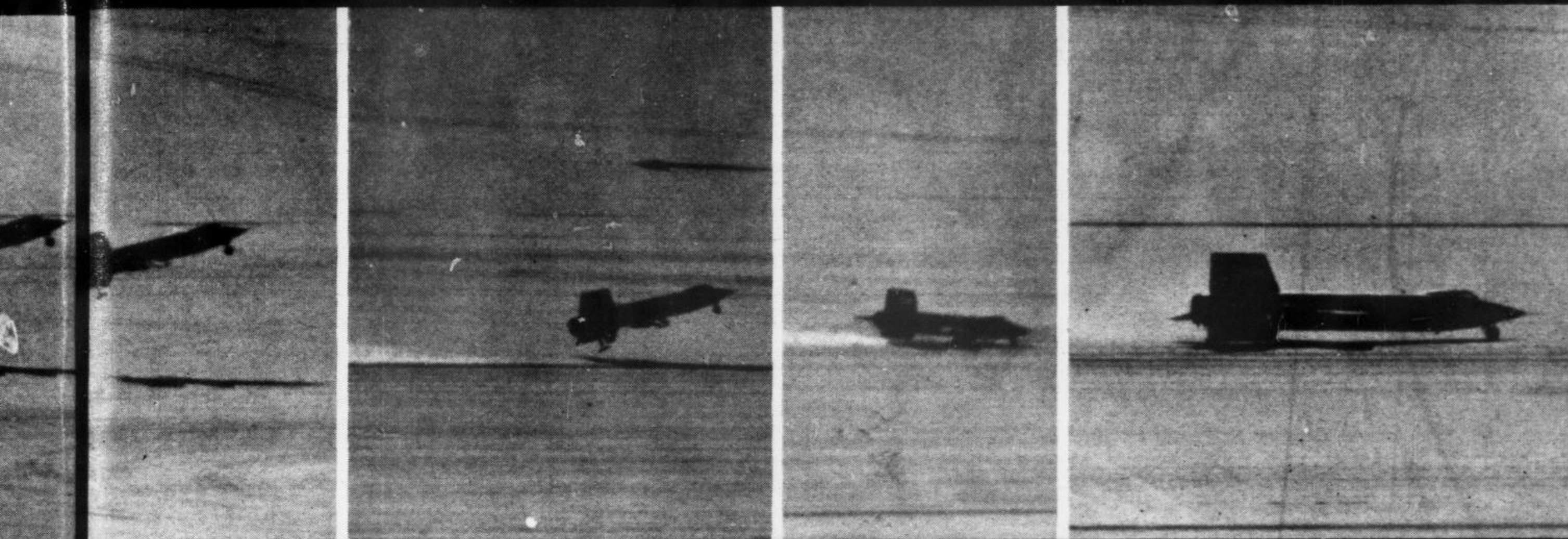
The dark-haired man who recently entered the Physiological Training van now emerges. He is dressed in a shimmering, silvery garment that catches and reflects the rays of the rising sun. Black, ankle-length boots cover his feet, and white gloves, with thick black stitching, encase his hands. He carries a white helmet with a clear plastic visor, obviously made to fit to the neck of the strange, silvered garment. Another man walks with him.

Chatting easily, the two men stroll over to the X-15. They climb a ladder that leads to a small platform, and there they look out over the busy scene as they exchange final comments. The platform allows the pilot of the X-15 access to his cockpit while it sits twenty feet or so above the ground.

The metallic voice of the loud-speaker blares: "Five

FLIGHT SEQUENCE. Dropped from the wing of B-52 jet-bomber, the X-15 uses its own rocket power to accelerate to speeds in excess of 4000 miles an hour. After it reaches maximum altitude, the rocket plane glides down to earth on reaction control. Speed heats the body to furnace temperature, but efficient air-conditioning system protects the pilot

from harm. Finally, after a last cork-screw turn to brake excessive speed, the X-15 banks towards the dry lake-bed it uses for landing. It skids through the dust of the lake-bed for more than a mile before grinding to a halt. Pictures below show steps in the landing, from the approach to the landing strip to the settling of the rear and front wheels.



minutes; five minutes."

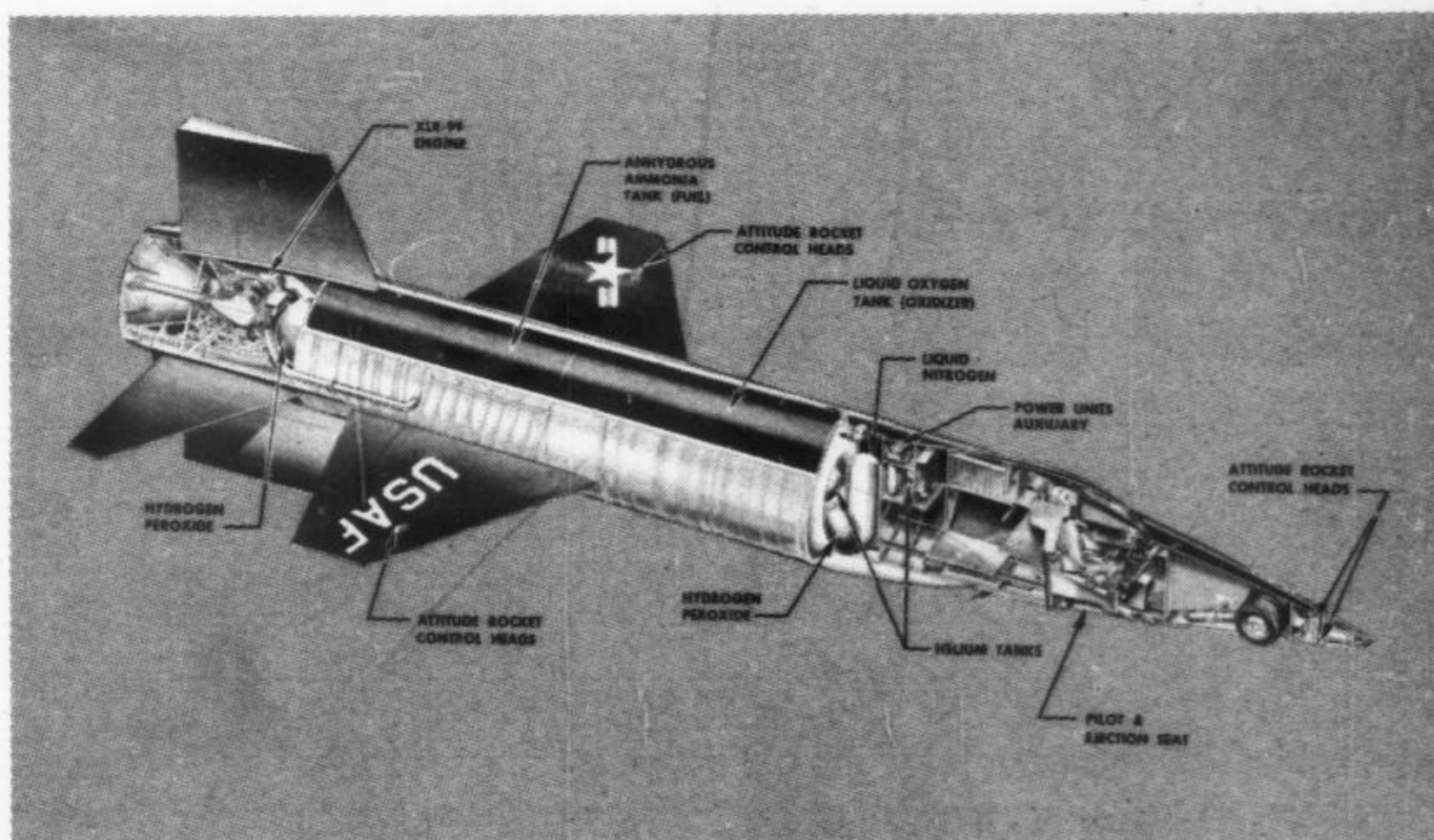
The man in the silvery suit climbs into the tiny cockpit of the X-15. His helmet is lowered over his head and secured to the metal neckband of his suit. Scott Crossfield, North American Aviation test pilot, is strapped into the pilot seat. On the ground, hoses are disconnected from the B-52 and men begin to clear the area. The X-15's canopy is lowered into place and the pilot is finally, irrevocably alone within. A tractor attaches itself to the front landing gear of the big ship and, despite the almost absurd difference in size, begins to tow the giant bomber and its black burden slowly along the flightline.

The spectators leave. In cars and trucks they hurry to various vantage points from which they'll be able to see the B-52 take off.

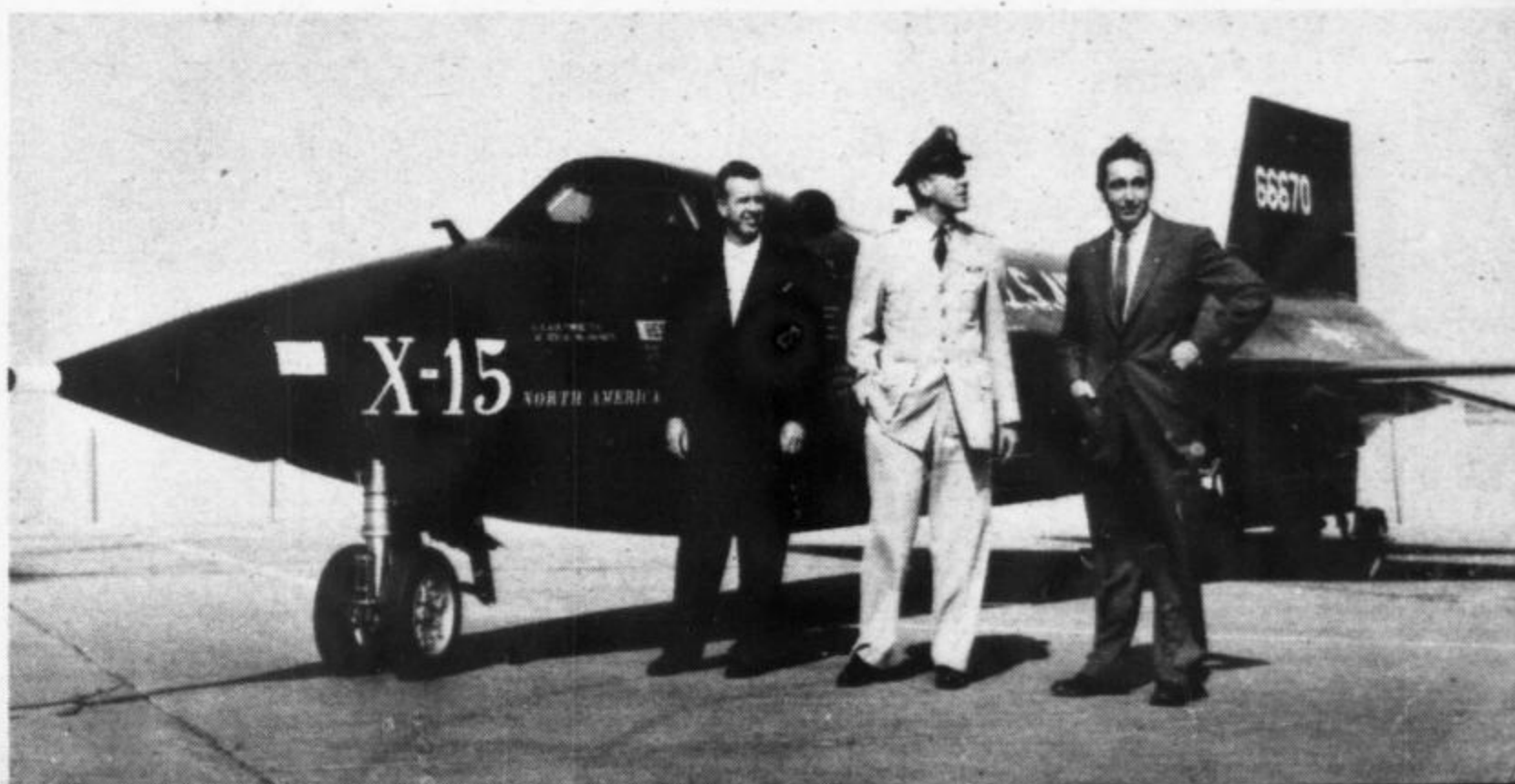
At a point farther down the line, the B-52 comes to rest once more and stands waiting. A long caravan of vehicles — a giant crane, a few red "crash wagons," three ambulances, a ground-control van, and assorted cars and trucks — snakes away, heading out over the desert.

Now, one by one, the B-52's eight jet engines spring to roaring life. The bomber trembles, as if released from a long captivity, and begins to move. She rolls along the taxiway, heading for the south end of the 15,000-foot Edwards runway. At the head of the runway she pauses and turns in the direction of take-off — practically due north. The pulse of her engines quickens, the roar grows deafeningly loud, pierced by the thin, whistling wail char-

(continued on page 53)



SCHEMATIC. Drawing above shows parts of rocketship. Below, the three pilots who will fly the X-15. From l to r are Joseph Walker, Major Robert White and Scott Crossfield.



The Director of our Space Program
lays down a bold challenge —

AMERICA WON'T

by T. Keith Glennan

Director, National Aeronautics and Space Administration

WHY space travel? Why the expenditure of vast sums for going beyond our comfortable earth into alien regions?

These questions undoubtedly lie in the minds of many Americans. In answer, I am reminded of a story told about Mark Twain. Talking to a riverboat pilot at the time steam was beginning to replace sail, Twain answered the protests of the pilot against the new-fangled invention by saying — “when it’s steamboat time, you steam.”

And today it’s time for space research and space travel.

It is in this spirit that I report our NASA venture — perhaps I should say — adventure. For the years ahead give promise of unequalled excitement and achievement in areas of human effort which until very recently have been accepted as fit subjects only for comic books and Sunday supplements.

The prelude to NASA goes back to the National Aeronautics and Space Act of 1958, in which the Congress declared; first, “that it is the policy of the United States that activities in space should be devoted to peaceful purposes for the benefit of all mankind,” and, second, “that the general welfare and security of the United States require that adequate provision be made for aeronautical and space activities.”

But the third statement, to engage in “such other activities as may be required for the exploration of space,” projects us into an entirely new dimension of human activity. The exploration of space! For the first time in the long history of legislation these words have been written into a law. It is safe to predict that the world will never be quite the same again.

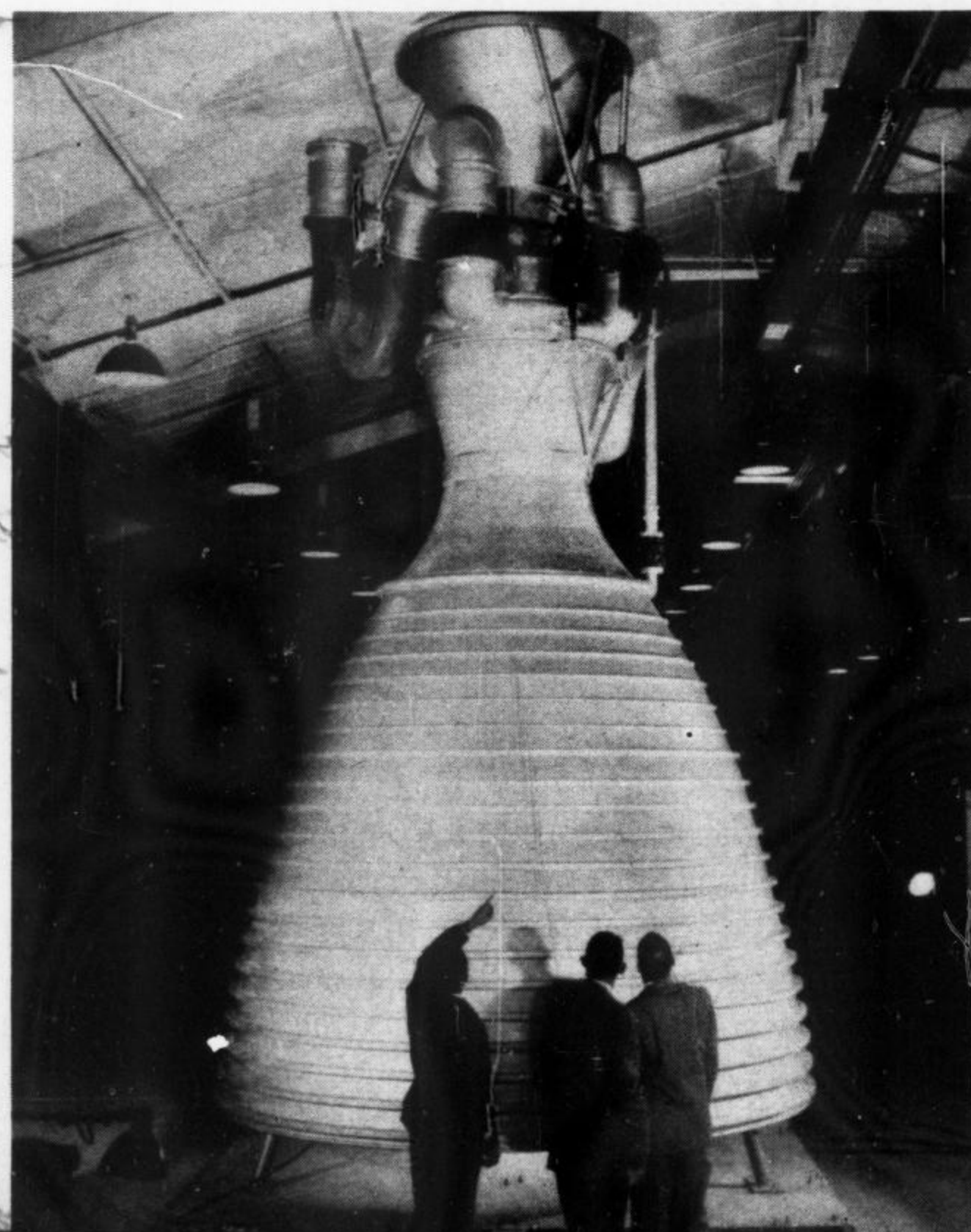
The *Exploration of Space*, then, is NASA’s job.

I believe space exploration to be a useful and necessary activity of our Federal government. In the first place, research in space will turn up new information that ultimately will be useful to man. Weather forecasting, com-

(continued on page 44)



SPACE PROJECTS. Author T. Keith Glennan shows Pioneer payload model of a successful solar probe. This full scale mockup, below, is part of future NASA giant booster project.



BE SECOND BEST!

NUCLEAR POWERED ROCKET. Here is
model of NASA designed space vehicle.



MYSTERIES OF



INDEXED BY P.A.L.

THE SOLAR SYSTEM

A leading authority discusses what we know—and don't know—about the nine planets that circle our sun

by Willy Ley

Just about three hundred years ago the French mathematician and physicist Blaise Pascal observed that human knowledge resembled an expanding sphere. "The larger it grows," he said, "the larger the number of points where it touches the unknown."

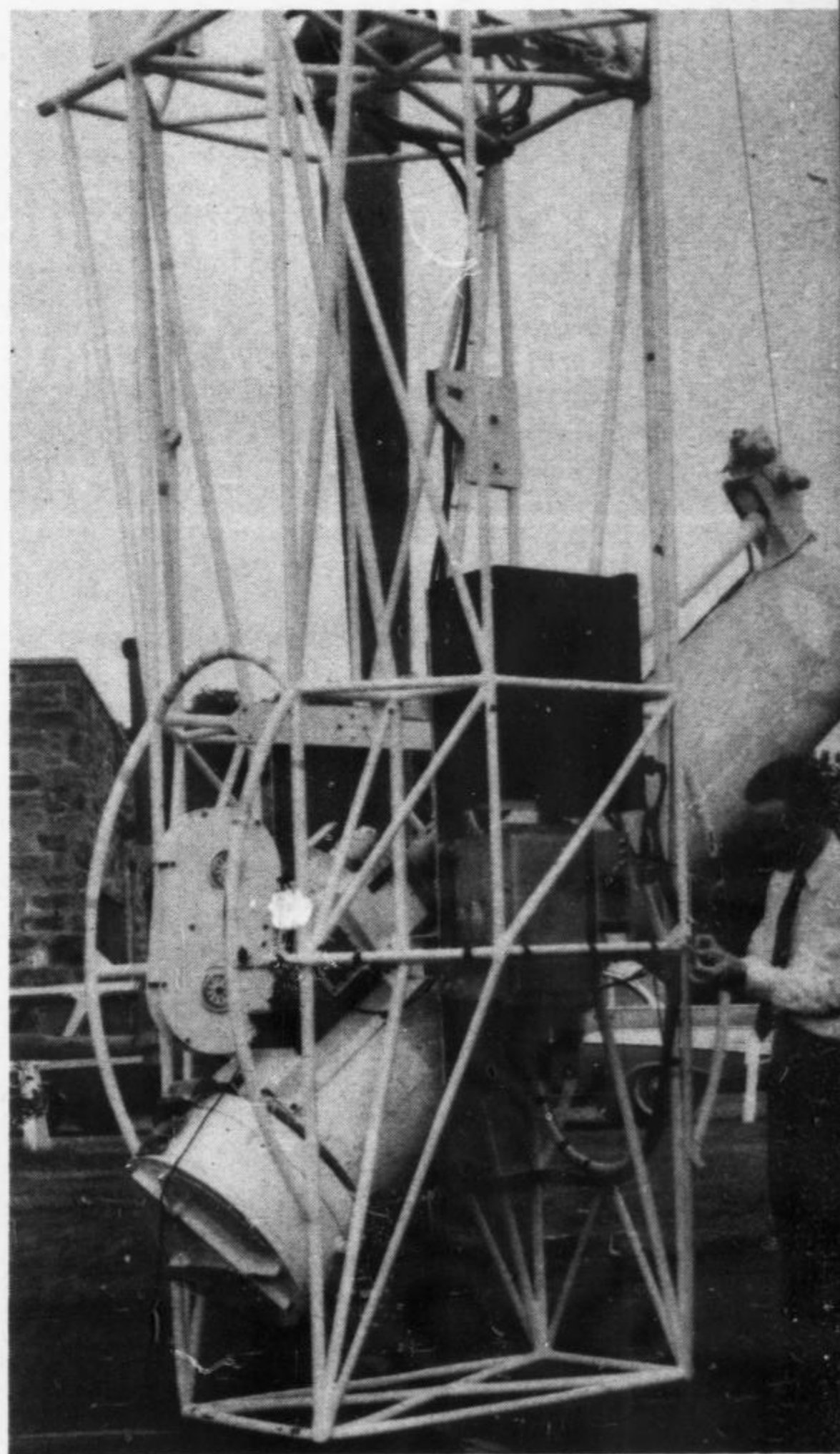
Though Pascal had mainly mathematics in mind, his maxim applies to any other field of knowledge. The hydra of classical mythology was a monster which sprouted two heads for each one that was cut off; in modern science every question that has been answered somehow begets half a dozen new ones.

Astronomy is a fine case in point. Before the invention of the telescope the universe looked simple. There was the sun and the moon and there were the five planets, Mercury, Venus, Mars, Jupiter and Saturn. There also was a large number of "fixed stars" and that was that. But then the telescope was invented and for a while it looked as if only answers were forthcoming.

The planet Venus did show phases like our moon, as had been suspected. The planet Jupiter was accompanied by moons of its own, something nobody had guessed. There were mountains and valleys on our moon as some philosophers had asserted all along. Of course there were a few uncertainties left. The planet Saturn seemed to have "ears" or "handles" which didn't make too much sense. But one could hope that bigger and better telescopes would solve such problems and soon Christian Huyghens of The Netherlands did see that the "handles" were actually a ring around the planet.

But as factual knowledge grew the number of questions grew too. They are all new questions, of course, questions which could originate only because new knowledge had been added. The great astronomer Hipparchus of classical antiquity would simply be helpless in an astronomical symposium of today—even assuming that he has no trouble understanding our languages—and Galileo Galilei and Johannes Kepler would hardly be better off. The term "a retrograde satellite" would mean nothing to Hipparchus though it probably would make sense to Kepler. But what, Kepler might ask, is a "barred spiral nebula"?

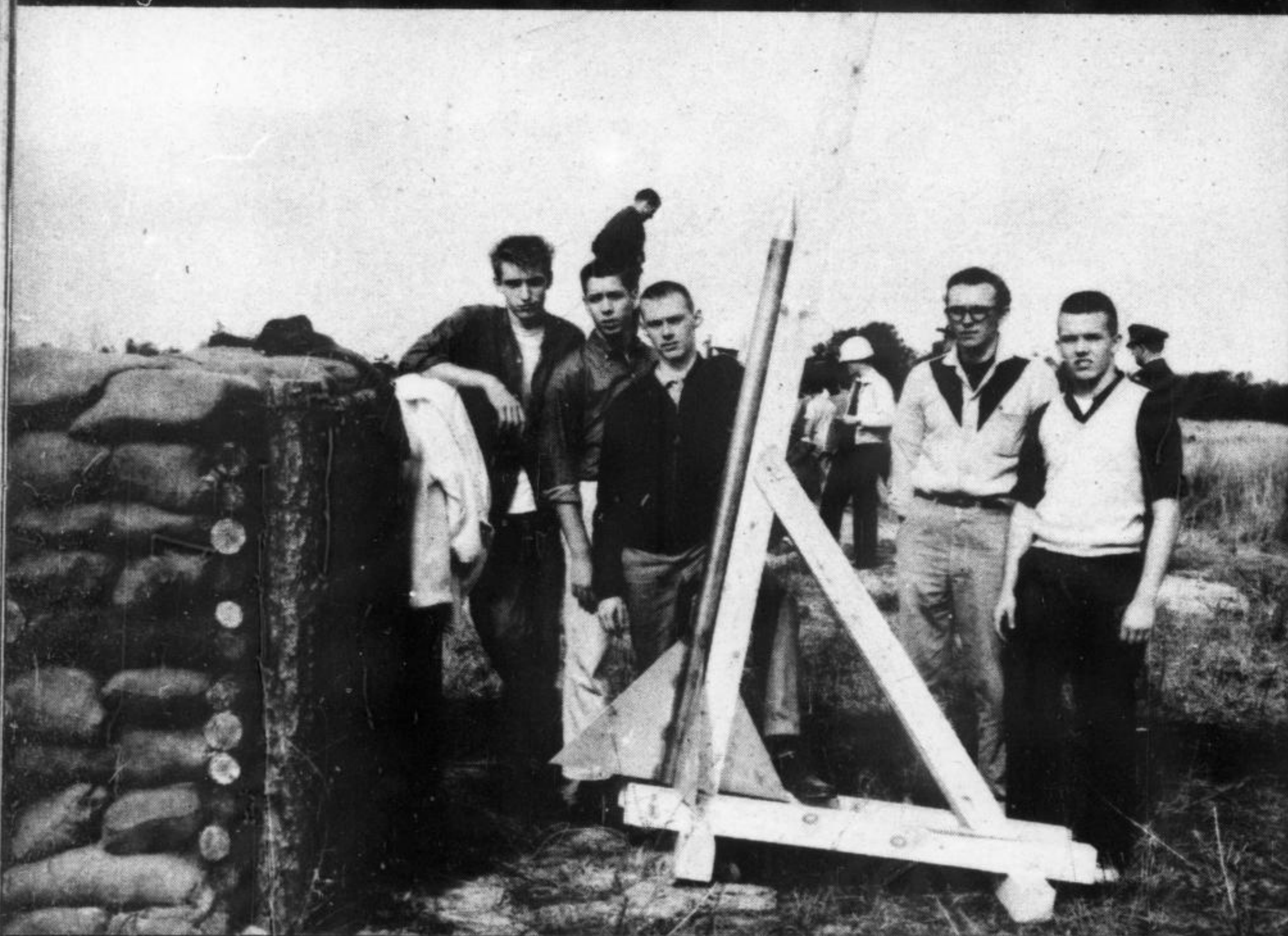
Just as, 350 years ago, the newly invented telescope provided many answers, the dawning era of space travel will do the same for us. It
(continued on page 60)



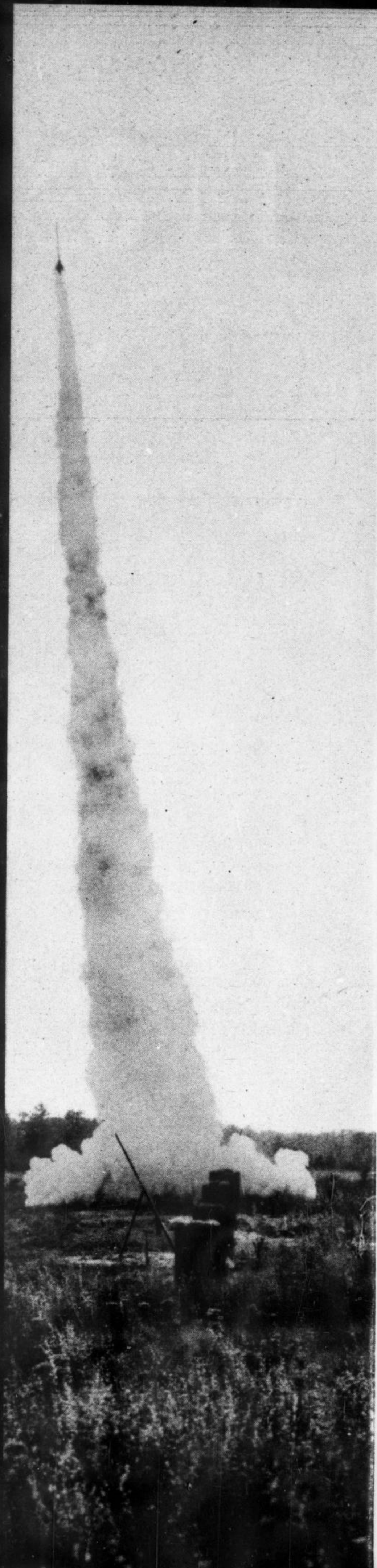
STRATOSCOPE. Dr. Martin Schwarzschild adjusts controls on 12-inch solar telescope that was lofted above 99% of our earth's atmosphere by balloon in order to make distortion-free photographs of the sun's surface.

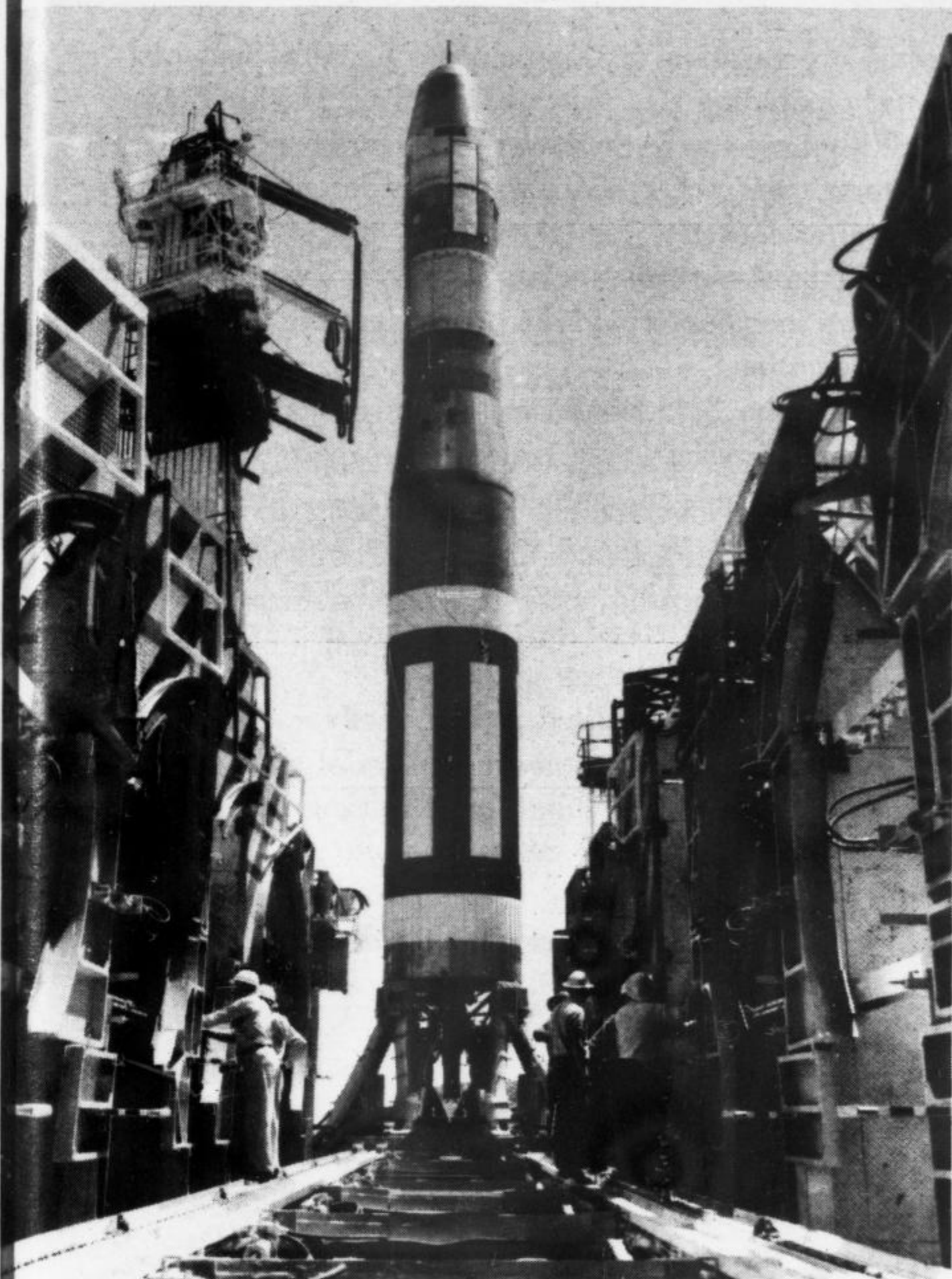
AMATEUR ROCKETRY: Good or Bad?

SPACE WORLD presents a symposium
on some of today's conflicting opinions

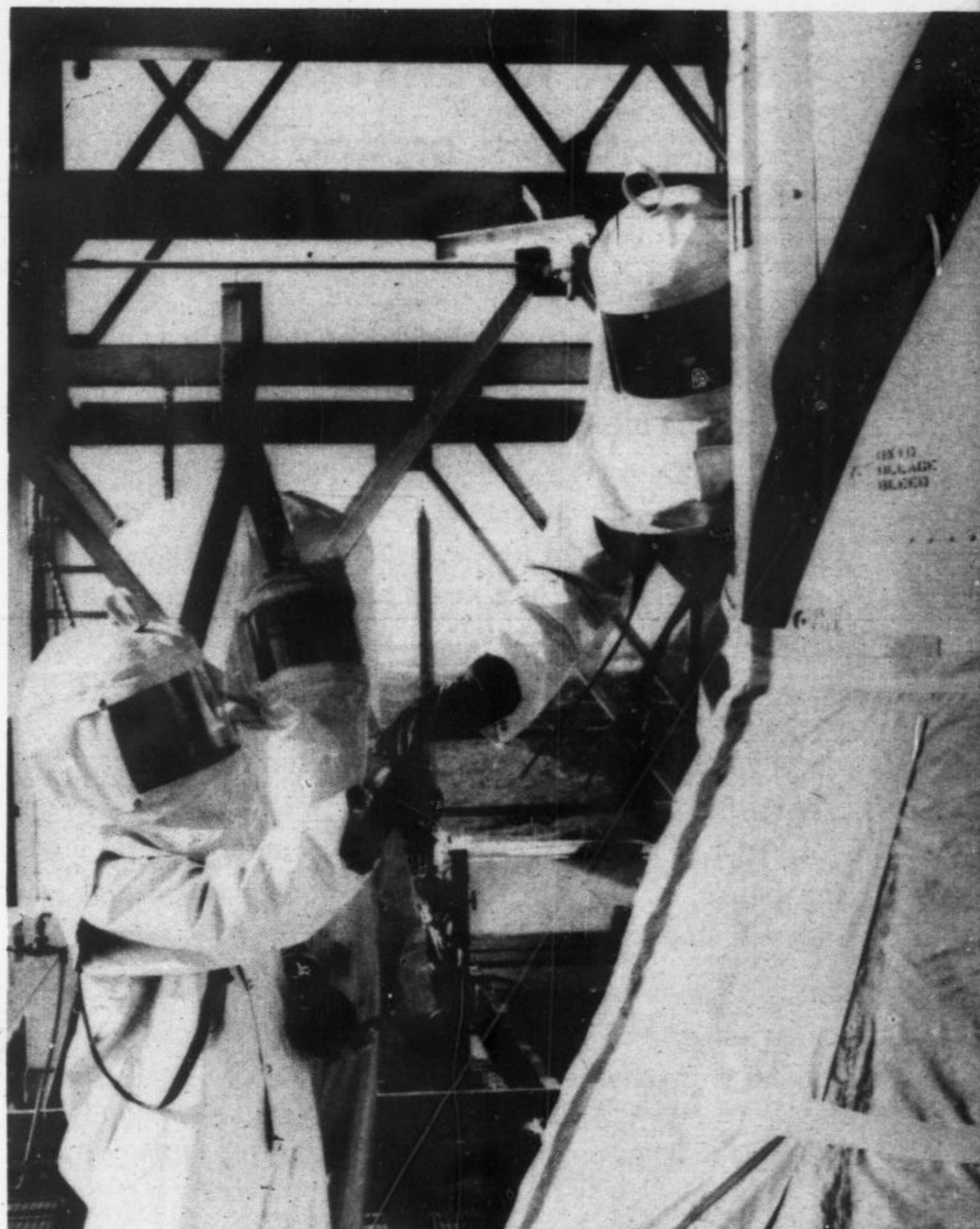


AMATEUR APPROACH. Richmond, Virginia rocket club members pose with their 58-pound "Hercules" before firing. Critics object to amateur activities because they are dangerous unless properly supervised, and of little educational value.





PROFESSIONAL APPROACH. The slim and powerful USAF Titan is made ready for launching by combined efforts of engineers and scientists working to professional standards.



SAFETY PRECAUTIONS. Unlike some amateurs who make few concessions for their safety, professional rocketeers have a healthy respect for power of explosive missile propellants.

by Ralph Tenner

ON March 16, 1926, the world's greatest amateur rocket enthusiast shot off a missile that went 184 feet, less than many such amateur feats today. His name was Robert H. Goddard.

He was an "amateur" simply because in his day rocketry as a science was unborn as yet. He had no organization behind him, no trained staff of engineers, no million-dollar fund to finance him.

His name can be multiplied in the following 12 or 15 years, before rocketry became "big time", by those of Wernher von Braun of Germany, Blagonravov of Russia, and many others around the world. They were all "amateurs" — then. Today, they are enshrined in history as the great pioneers of astro-science.

After Sputnik I in 1957 first broke the chains of earthly gravity on its free-wheeling spin around the world, a whole new breed of eager young amateurs were inspired in America, and other nations, to become "Goddards".

Now, there is admittedly one big difference between that immortal "amateur" and his imitators of today. Goddard *had* to experiment because liquid-fueled rockets were absolutely unknown. Today's young neo-Goddards are hardly "pioneering" by duplicating what he and many

other professionals have already fashioned into workable hardware.

But in a larger sense, the serious amateur rocketeer of modern times is quite like Goddard — he wants to gain *know-how*. Note the word "serious". If he is out for "kicks" or "big bang" thrills, he is treating rocketry as a "fad", not a stepping stone to his future scientific career. In that case, he has no earthly excuse to risk his own safety, or that of others, in experimentation that can be dangerous if done improperly.

But assuming the amateur is serious, and intends to follow a career related directly or indirectly to America's missile and space program, then his experimentation can be immeasurably worthwhile as his own advance training. As Willy Ley, former amateur and present pro, so aptly puts it, "if the first generation of experts had to begin as amateurs, what does anyone expect the next generation to do? Learn how to draw parts with great accuracy without any knowledge of what these parts do, where they fit in, and why they exist in the first place?"

Yet, there are many conflicting viewpoints on today's amateur rocketry, which is estimated to total thousands of "clubs" and anywhere from 50,000 to 250,000 mem-

(Continued on next page) 27

AMATEUR ROCKETRY: Good or Bad? *continued*

bers. Most members are teen-agers 13 to 17 years old. They have banded together all over the United States to engage in rocket study and "shoots".

The young missilemen have been variously described as "budding scientists", "rocket delinquents", and "juvenile pyro-maniacs". Some states have practically outlawed their activities. Local fire-departments and police authorities have broken up their meets and imposed fines. Powerful organizations, notably the American Rocket Society, have condemned amateur rocketry unequivocally. Groups of citizenry have tried to ban all rocket launchings by these youngsters, considering it "dangerous".

Are they right?

SPACE WORLD presents a symposium of several leading points of view on this highly controversial and immensely important subject.

The American Rocket Society

Dating back to its formation in 1930, the American Rocket Society is America's oldest, largest and most re-

spected organization in this field. Its founders and early greats — including G. Edward Pendray, David Lasser, and Willy Ley — were themselves amateurs experimenting with their own rockets. Such experimentation rapidly declined after rocketry was taken up by professionals, and in 1947, the American Rocket Society wrote into its by-laws that members could no longer engage in private experimentation.

In 1958, the ARS conducted an investigation of this era's amateur rocketry and issued a 76-page report on the findings — but only in southern California. This regional report purported to prove amateur rockets were more lethal than autos. Their final statement was "The ARS reaffirms its strong stand in opposition to any amateur (rocketry) experimentation whatsoever...."

The ARS must be credited with basically good motives. They regard "the *positive* encouragement of young people to study rocket and space flight principles as equal in importance (to opposition)".

Armed Services Supervision

For this reason, they pledged in their 1958 report to encourage some supervisory system of the Department of Defense to aid amateurs. But as of today, after DOD tried this plan for the two intervening years, the ARS is "skeptical" that such supervision can *ever* be feasible.

BEFORE. Members of Arlington, Va., rocket club place dummies into position beside their rocket launching site.

AFTER. Battered dummies show power of rockets in this demonstration held under U.S. Second Army's supervision.



Is this true? Let the DOD speak for itself.

The Department of Defense, through the Armed Forces, has for over two years tried a positive approach in order to find a way to utilize the "brain bank" of young, would-be rocket experts.

Soon after the Army orbited Explorer I, America's first satellite, on January 31, 1958, the Second United States Army was empowered to aid the efforts of "teen-age space pioneers with their eyes on the stars."

They appointed technical supervisors at amateur shoots, provided data for fabricating small rockets, and issued a safety code to reduce dangers to a minimum. Army sponsored classrooms gave 18-week informal courses in the science of rocketry.

Booklet

Amateurs were also allowed to use two Army firing ranges in the crowded East for rocket tests, thus eliminating the hazard to civilian communities. In November 1959, at Camp Hill, near Bowling Green, Virginia, one amateur rocket soared an estimated 15,000 feet, an unofficial record.

A free booklet is available to all amateurs who write to Headquarters, Second U.S. Army, Fort Meade, Maryland. Called the "Amateur Rocket Support Guide", it gives valuable information that will increase the thrilling re-

sults of the amateur and reduce the lurking dangers. The armed forces stress safety. Obviously, they believe that amateur rocketeers should be encouraged *provided* that there are sufficient safeguards. Unlike the American Rocket Society, the Department of Defense has not despaired of the possibility of establishing such safeguards.

The One-Man Organization

One Army officer has pioneered in trying to solve the problems of amateur rocketry. He is Captain Bertrand Brinley, Project Officer, First U.S. Army Amateur Program. For almost two years, Captain Brinley has been trying to show how our "army" of amateurs can be guided toward a career as the kind of professional rocket-men vital to America's future.

He has recently published a paperbound book, *Rocket Manual for Amateurs* (Ballantine, 1960), that may cause some amateurs to wince when reading it. Captain Brinley asks why they want to experiment with rockets? What they hope to achieve? And are they willing to adopt safety rules?

If any amateur is shooting off rockets as a "thrilling hobby", and thinks it "sissy" to play safe or obey anti-rocket laws, Captain Brinley frankly tells him he is a potential "killer" and has no business fooling with potentially lethal weapons. (continued on page 48)

MODEL ROCKETRY. The National Association of Rocketry, founded by G. Harry Stine, encourages the use of safe models.

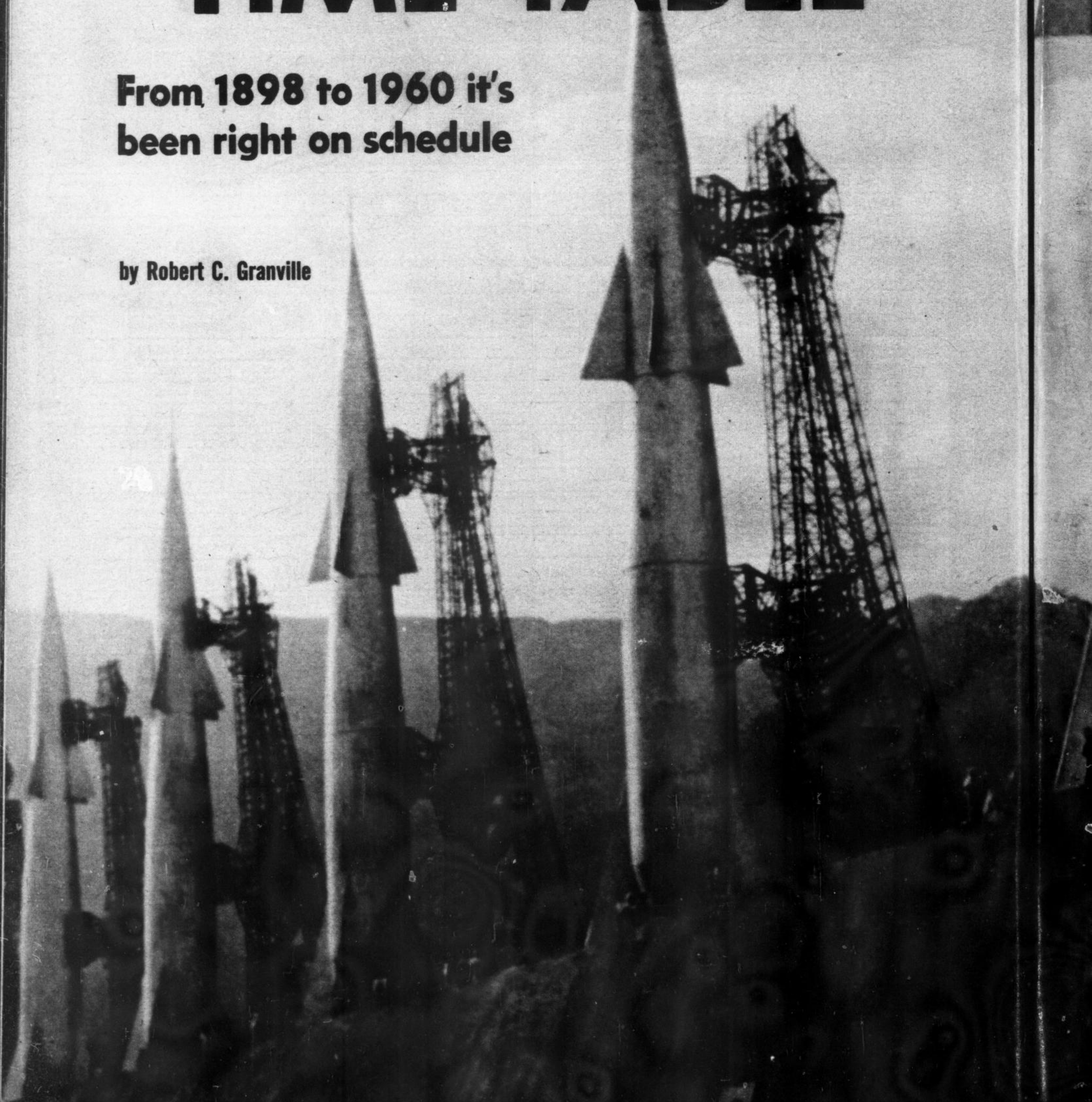
SUPERVISED SHOOT. U.S. Army supports many rocket clubs and provides safe facilities for amateur launchings.



THE RUSSIAN TIME TABLE

**From 1898 to 1960 it's
been right on schedule**

by Robert C. Granville





MAN INTO SPACE. Russian scientists Leonid I. Sedov, right, and A. Blagonravov told reporters Soviets could put man into space now.

When the Russians took their first historic steps toward the stars, a shocked and grossly misinformed America met the news with disbelief.

How, people wondered, did Russia, a backward land of starving peasants and illiterate proletarians that had just been devastated in a terrible war, beat the most sophisticated and advanced countries of the West into space?

Some claimed the Russians got their rockets and their know-how from a colony of German engineers captured at Peenemünde.

Not so, said our own officials.

The cream of German rocket engineers, equipment and plans were an American prize. Russia, at most, got only a few partially assembled V-2s and a few technicians. The directors of Peenemünde, Wernher von Braun and Dr. Walter Dornberger, are both working in America today.

How then did the Russians forge ahead?

Because they planned it that way—a long time ago! And worked very hard to realize their goals. Success came as no surprise to the Russians, it was merely one of the steps on a time-table that stretches back more than fifty years.

Russian astro-science began in 1898 when I. V. Mescherski and K. E. Tsiolkovski first wrote on the principles of rocket flight. This early interest was followed up in 1928 by N. A. Rynin who published a monumental 9-volume treatise on astronautics theory.

Then in 1929, only three years after Robert Goddard of America had flown the first liquid-fueled rocket in history, the Russians moved from mere theory to successful experimentation. That year an organization of scientists and engineers called GIRD (after the initials of Russian words for *Group Studying Reactive Motion*) was formed to produce rocket engines and liquid propellants.

Three years later F. A. Tsander built and successfully tested a "modern" rocket motor operating on kerosene and liquid oxygen, and V. P. Glushko of the distinguished Soviet Academy of Sciences made test-stand firings of liquid-fueled rockets he had

(Continued on next page)

THE RUSSIAN TIME TABLE

continued

designed in 1931 and 1932.

These enthusiasts thought of rockets as a means of achieving space travel, but the Soviet government, realizing their enormous military potential, organized a rocket research program in 1934 for military purposes.

This was only 5 years after Germany had embarked on its program to develop rocket weapons, and 8 years before a similar systematic research program began in the USA.

In 1935, the USSR abruptly shut the door on the publication of original data of all its rocket experiments. From then on, the world, already threatened by the spectre of war, heard little of the vast, hidden activity in Russia that was producing high-powered missiles of military value.

One significant leak occurred in 1935 when the world learned that a rocket designed by L. S. Dushkin and M. K. Tikhonravov was propelled to an altitude of 6 miles. In America at the time, Goddard's record rocket had only gone 7250 feet high—1 and $\frac{1}{3}$ miles.

After this brief glimpse, war-time censorship closed off all reports of Russian rocketry for the next ten years.

After World War II, news about the Russian space program began to trickle through the Iron Curtain once again. Russian rocketry went forward rapidly in non-

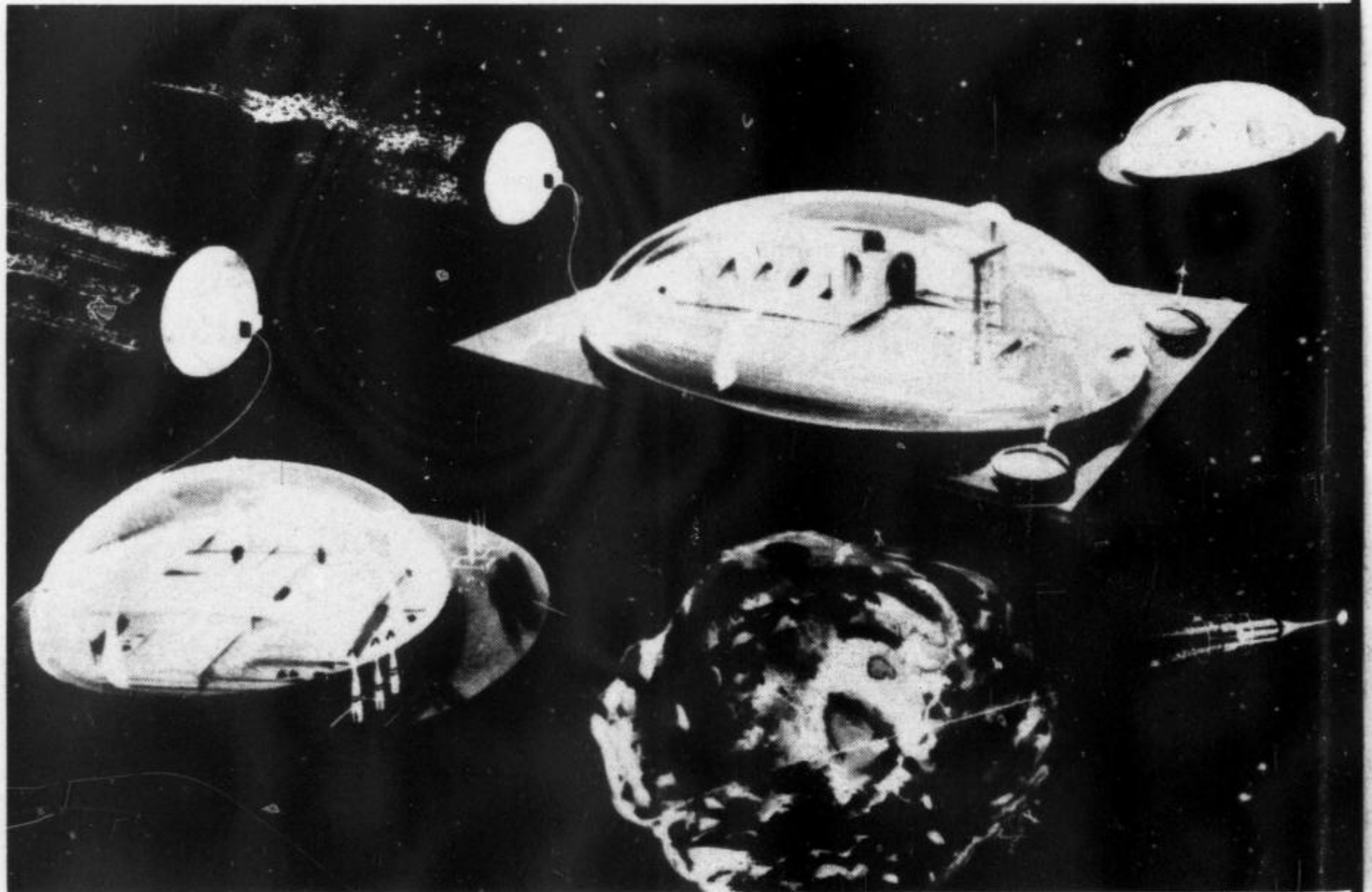
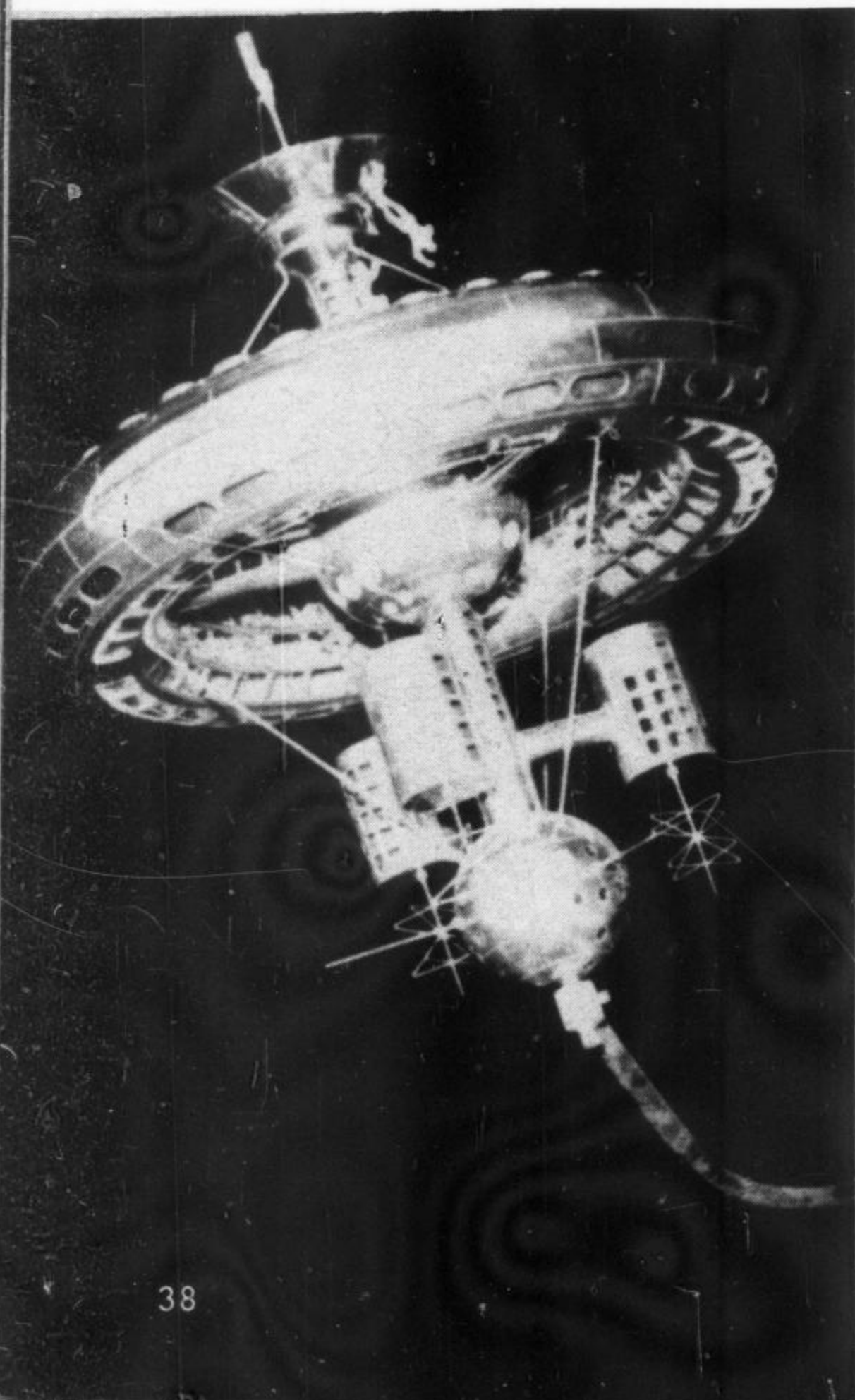
military applications. By 1949, the Soviets were carrying on an advanced upper atmosphere program with research rockets, achieving parachute recovery of instruments and animals.

The exact payloads, heights, scientific data and animals used were never officially released because censorship had clamped down tightly again, during the tense period of the *Cold War* and Korean conflict. But Russia was already, in effect, off and running in the "space race" while America hadn't heard the starting gun and would not even leave the post until years later.

Yet we should have been warned. In this period, two general subjects received much attention in the Soviet press—the artificial earth satellite and rocket flight to the moon. The technique of placing vehicles in orbit was thoroughly examined from all angles. But American experts dismissed the Soviet releases as "Sunday Supplements" with no serious intent behind them.

The start of an *official* Soviet program aiming at manned space-flight can be traced back to a significant statement by Academician A. N. Nesmeyanov, given to the World Peace Council in Vienna. The date: November 27, 1953. The words: "Science (in Russia) has reached a state when it is feasible to send a stratoplane to the moon (and) to create an artificial satellite of the earth."

Unlike the supercilious sniggering attitude in America, there was early acceptance of the possibility of space flight by not only the Soviet scientists but the Soviet



INTERPLANETARY FLIGHT VEHICLES. Artist's conception of the type of space-ships that will be assembled at a space station for eventual manned flights to the moon and to the planets beyond.

COSMIC STATION. This model of an orbiting space station was recently exhibited at Moscow science exposition. Space station is first step on Russian schedule for "Interplanetary Communications."

government officials also.

A Russian encyclopedia of June, 1954, contained an article by Tikhonravov titled, "Interplanetary Communications" (the Soviet expression meaning "manned space flight"). As of the end of 1957, there was no corresponding entry in any of the encyclopedias of America or the Western world.

One of the most startling disclosures of Russian intentions was a report by V. A. Egorov, an astronautic authority, in which more than 600 trajectories to the moon were calculated by electronic computers between 1953 and 1955. All possible approaches to the moon were classified as misses, hits and circumlunar flights.

In July 1954, the most widely publicized moon treatise was presented in "The Road to the Cosmos", by Yu. S. Khlebtsevich. This is a name to be remembered, as it recurs today with increasing frequency.

Khlebtsevich suggested landing a mobile "tankette laboratory" on the moon, radio-controlled from earth, to explore the lunar surface and telemeter back its findings. He concluded that information so obtained would make possible a landing on the moon in the 5 to 10 years after his report appeared—namely, in the 1960 to 1965 period.

There is strong reason to believe Khlebtsevich's timetable has been faithfully followed. That could mean a Russian on the moon before 1965.

That such a "moon time-table" was probably established
(continued on page 46)



SUPER MISSILE. The recent firing of a new Russian rocket from the shores of the Caspian Sea to the Pacific Ocean demonstrated the power and accuracy of the missile.

MANNED MOON BASE. Russians have announced plans to follow up their lunar probes with large manned rockets that will establish first permanent bases on the moon. These will be used as outposts for launching further exploration.



SPACE

AUGUST 50c
VOL. 1, NO. 9

WORLD

The Magazine of Space News

EXCLUSIVE - A Russian scientist reports on THE SOVIET MAN IN SPACE

A list of every rocket shoot ever made
WILLY LEY'S COMPLETE ASTRO-CALENDAR



Alan Shepard



Virgil Grissom



John Glenn

THE FULL STORY:
HOW OUR SPACEMEN
ARE CHOSEN

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5660 BEVERLY BLVD
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SPACE WORLD

The magazine of space news • August 1961

CONTENTS

- 12 SOVIET MEN IN SPACE** by Inna Yavorskaya
A Russian scientist's report on steps that led to manned flight.
- 16 CHOOSING THE FIRST ASTRONAUT**
by Ernest Haussman
An account of selection procedures for our Mercury astronauts.
- 20 THE DIVIDING LINE** by Albert C. Hall
A prominent engineer takes a critical look at our space hopes.
- 22 THE NEW MAN TAKES OVER** by Stanley E. Degler
An interview with James E. Webb, newly appointed head of NASA.
- 24 EXTRATERRESTRIAL BASES #3** by Otto O. Binder
Spacemen will face hostile environments beyond moon and Mars.
- 26 INFLATABLE SPACE VEHICLES** by Robert Granville
A novel engineering approach to problems of space vehicle design.
- 30 JOBS FOR LOW-THRUST ENGINE** by Ernest Stuhlinger
A leading authority on propulsion discusses ion-drive engines.
- 35 THE COMPLETE ASTRO-CALENDAR** by Willy Ley
- 40 SPACE ARTIST AT WORK** by John Rublowsky
A visit with Roy Scarfo, artist at GE's Space Vehicle Division.
- 44 G-FORCES** by Willy Ley
All about gravity and how it affects manned probes into space.

DEPARTMENTS

LETTERS	4	39 NAMES IN THE NEWS
WHAT'S NEW	5	47 BOOK REVIEWS
ORBITING AROUND	6	49 SPACE VEHICLE #3: VANGUARD
QUESTION BOX	9	51 SPACE QUIZ
		53 RUSSIAN REPORT

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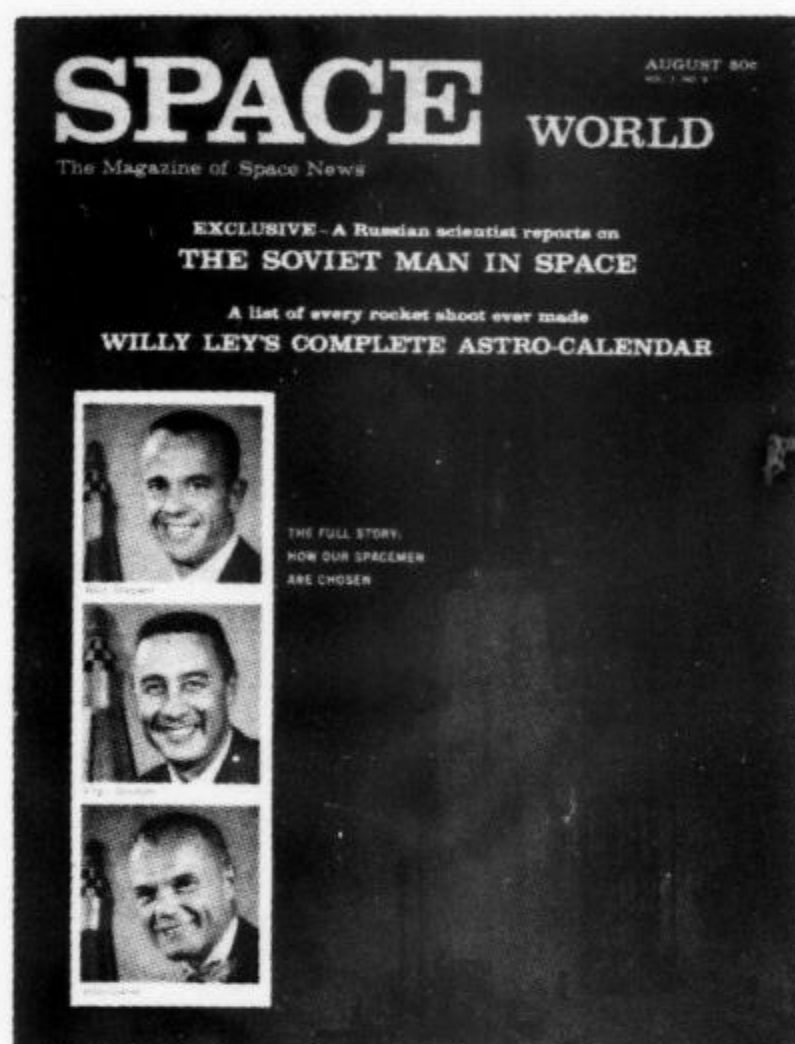
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57th Street, New York 19, New York



On the cover: These three men—John Glenn, Virgil Grissom and Alan Shepard—were chosen from among thousands to be the first Americans into space. For the story on how the choice was made, turn to page 16.

DATELINE MOSCOW:

**An exclusive report from the
Academy of Sciences of the USSR
brings you a step-by-step account
of the program which put the...**

INDEXED BY P.A.L.

SOVIET MAN IN SPACE

by **INNA YAVORSKAYA**

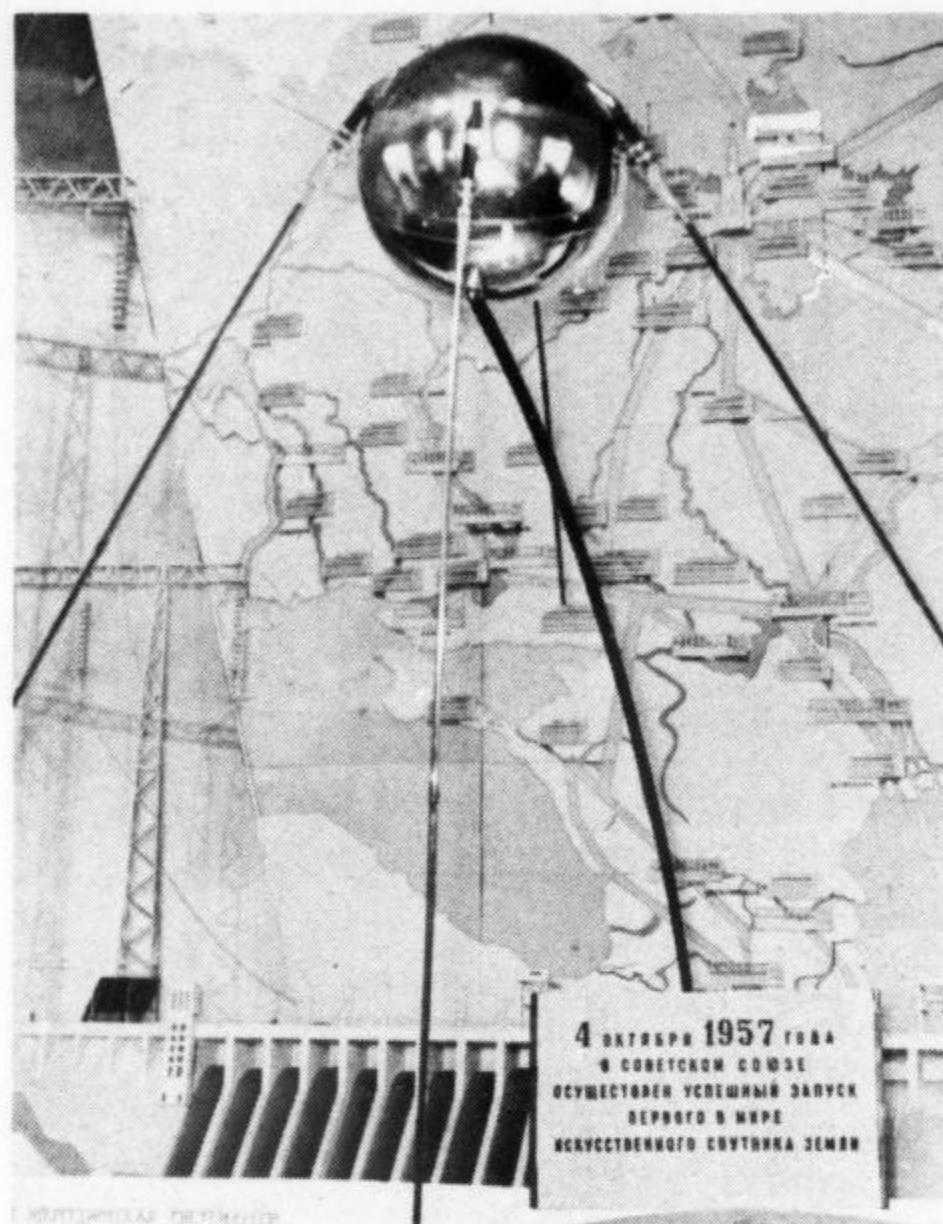
AT 2 a.m. on April 12, the temperature at Tyura Tam was in the low 40s when Yuri Gagarin, a young major in our Soviet Air Force, was roused by an attending physician. He had been asleep since early evening. Perhaps his heart beat a little faster than usual as he did his morning calisthenics. The winds were mild at five to ten miles per hour and only a few scattered clouds obscured the newly risen moon.

A storm center was developing over the Black Sea, some 1000 miles due west, but the meteorologists decided that it would not interfere with the morning's task.

By 6 a.m., Gagarin had undergone a thorough medical check and had eaten a low-roughage breakfast. Now began the final steps of his great adventure.

Technicians helped the young cosmonaut don his tightfitting pressure suit, after electrodes that would measure his heart-beat, temperature, respiration rate, etc., had been attached to his skin. Outside, as the last stars faded from the skies of southern Russia, a feverish activity centered around the huge rocket that stood on its launching pad. The big tanks were filled with liquid oxygen and refined kerosene, and engineers and technicians checked out the numerous pieces of delicate equipment that make up the heart of the rocket.

About two hours before launching, Gargarin walked



First Step. Sputnik I, first man-made satellite.

to the rocket service tower, his white plastic helmet with clear visor fastened to his dark-blue flying uniform. Gagarin shook hands with his comrades and stepped into the elevator. In answer to the excited waves of the technicians and engineers that swarmed about the launching pad, he held both hands over his head for a moment. The elevator carried him swiftly to the crown of the rocket. There, atop the tapered cylinder of the booster which towered some 100 feet above the ground, Gagarin stepped inside *korabl sputnik XI*, named *Vostok* (East), in honor of the first human passenger.

At 9 a.m. (Moscow time) the huge service tower moved away from the rocket on its tracks. Inside the cabin, a television camera pointed at Gagarin was activated. Lying on his back, in a form-fitting couch, his knees pulled up, Gagarin reported that he was ready.

Seven minutes later, the huge engines flamed into life. The *Vostok* lifted off the pad suspended on a curtain of flame. It hovered for a second, then gained speed and screamed upward. Inside the cabin, the crushing forces of acceleration squeezed Gagarin against his couch. As each booster ignited in turn, hurling the space ship higher and faster, Gagarin felt the heavy weight of acceleration.

At 50,000 feet, the huge ship began to tilt over

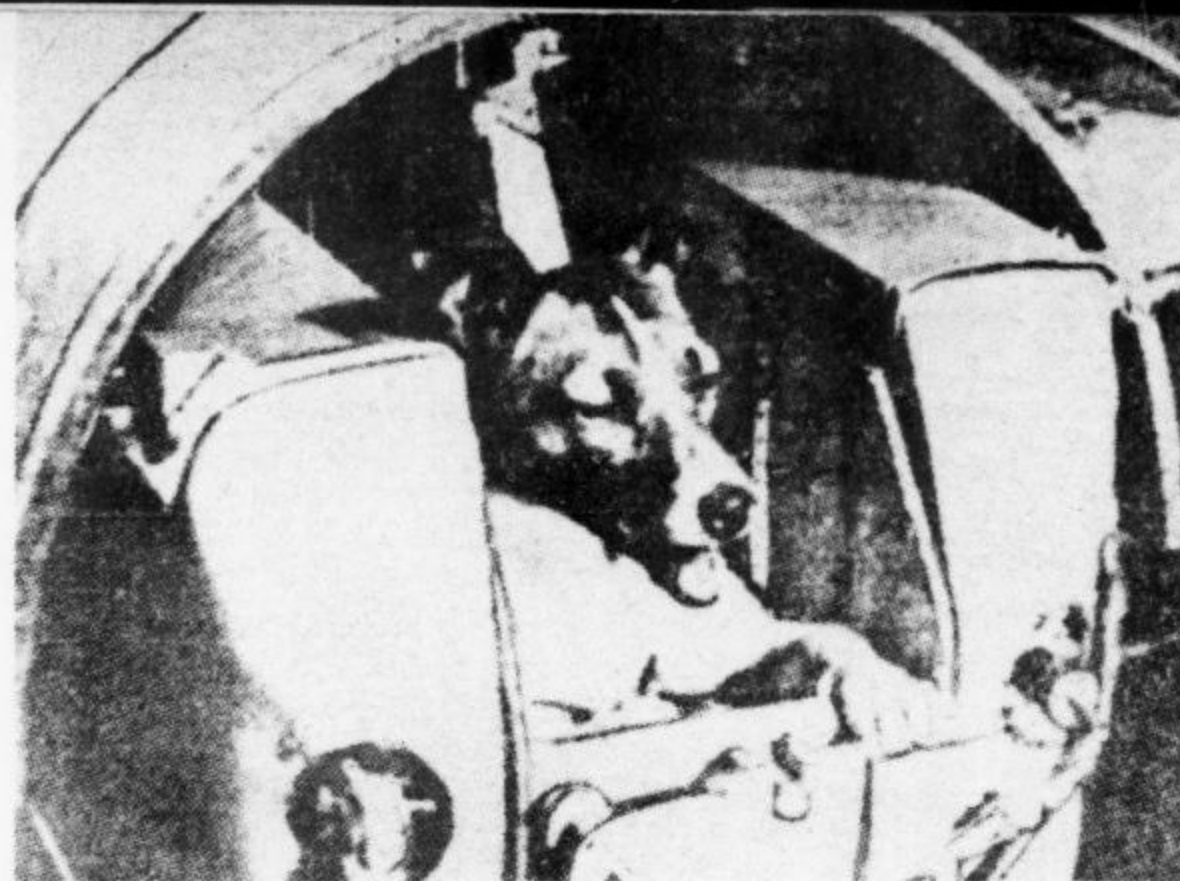
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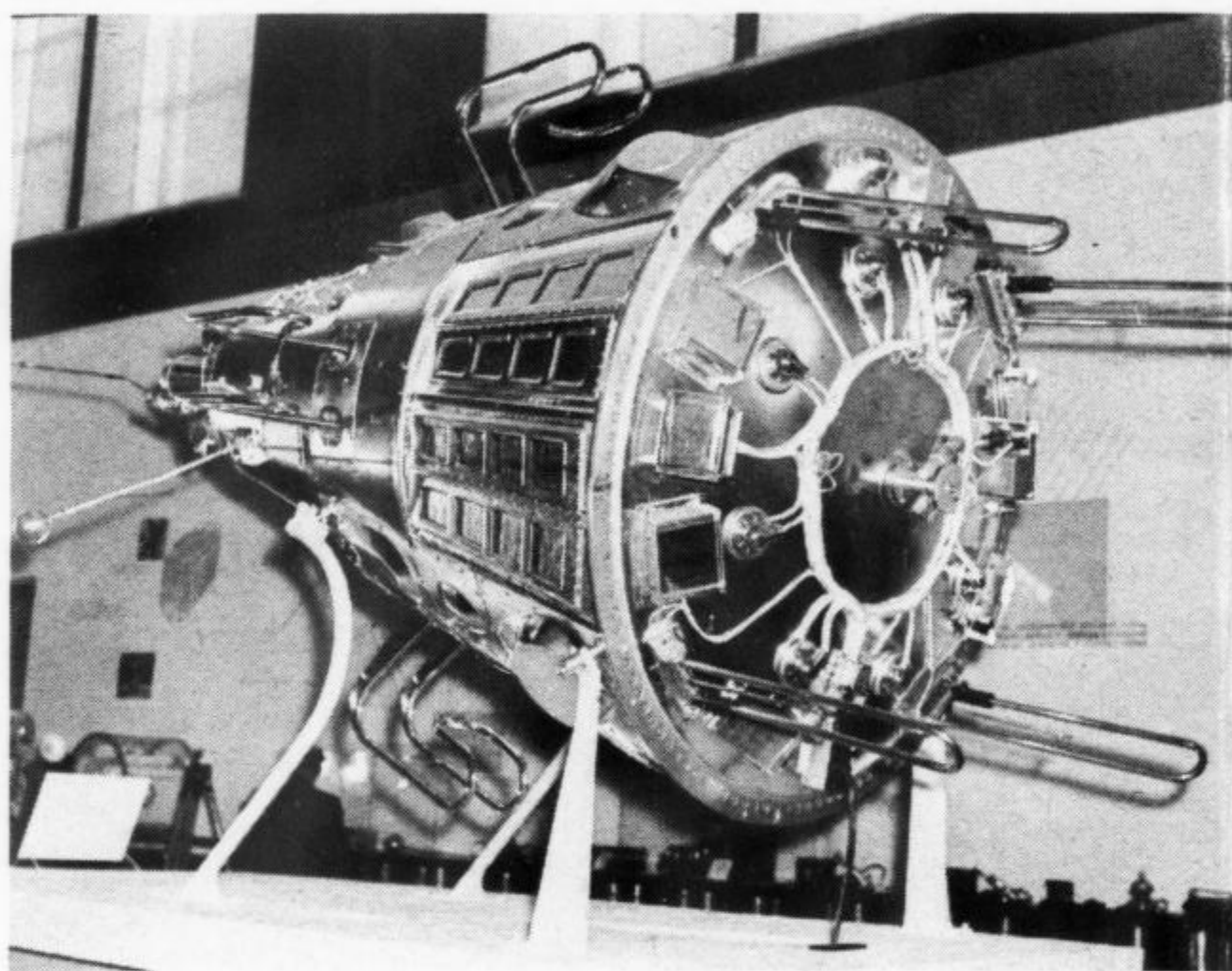
FIRST MAN INTO SPACE
On the morning of April 12, Yuri Gagarin mounted a capsule perched in the nose of a giant booster, orbited the earth, and returned successfully.



Second Step. Model of Sputnik II, Russia's second satellite, was put on display after the space vehicle was launched on November 3, 1957.



Passenger. The dog Laika, above, was placed into orbit aboard Sputnik II to test her reactions to weightlessness.



Third Step. Sputnik III, above, launched by Russians on May 15, 1958, was larger than current Mercury capsule.

Rocket launcher, life-support cabin and recovery

towards the northeast. Gagarin had time to glance out of his viewing port. "I see the earth in haze," he reported. "My, it is beautiful."

In five minutes, the last booster had ignited to push the capsule on the final leg into orbit. Separating from the space cabin, the empty rocket casing trailed behind as the *Vostok* passed over the Siberian land mass.

Eighty-nine minutes after launching, Yuri Gagarin stepped out of the *Vostok* in the pre-selected landing area. Man had ventured into space and had returned successfully. Soviet scientists and engineers had forged the path to the stars. For the first time, a man's eyes had seen the curvature of the earth. For the first time, a man had experienced weightlessness for more than a few seconds. An expectant world hailed the news and the name Yuri Gagarin will go down in history.

But this epochal scientific achievement was merely the culmination of work and effort that had begun years before. It was like the crown of an iceberg whose huge mass is hidden beneath the waters.

How, then, did our Soviet scientists accomplish this

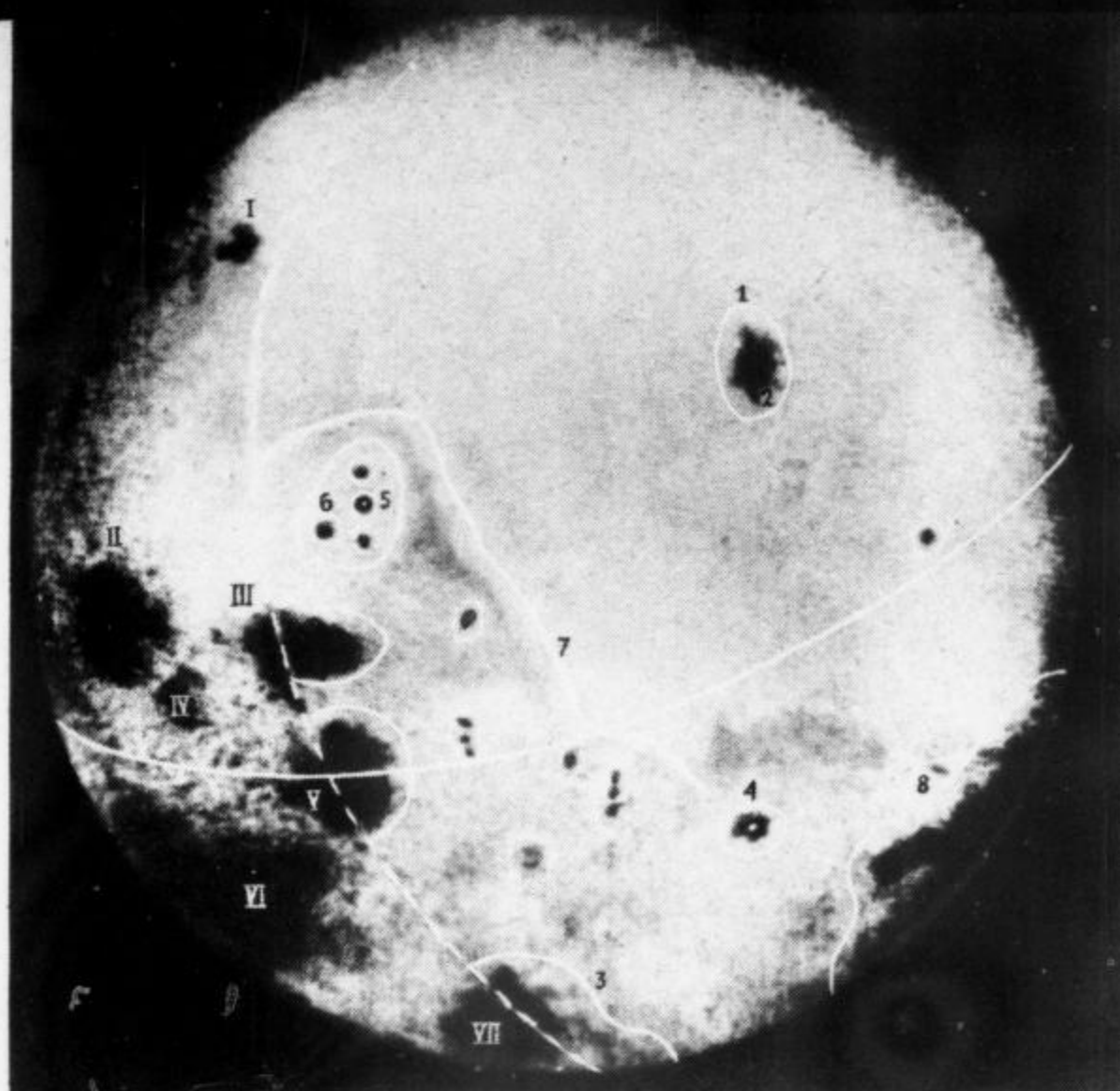
feat? What were the steps that preceded Major Gagarin's flight into space?

Three major problems had to be solved before manned flight into space could be undertaken—developing rockets for cosmonauts capable of overcoming the earth's gravity, insuring the safety of human travel in space, and arranging for man's safe return to earth.

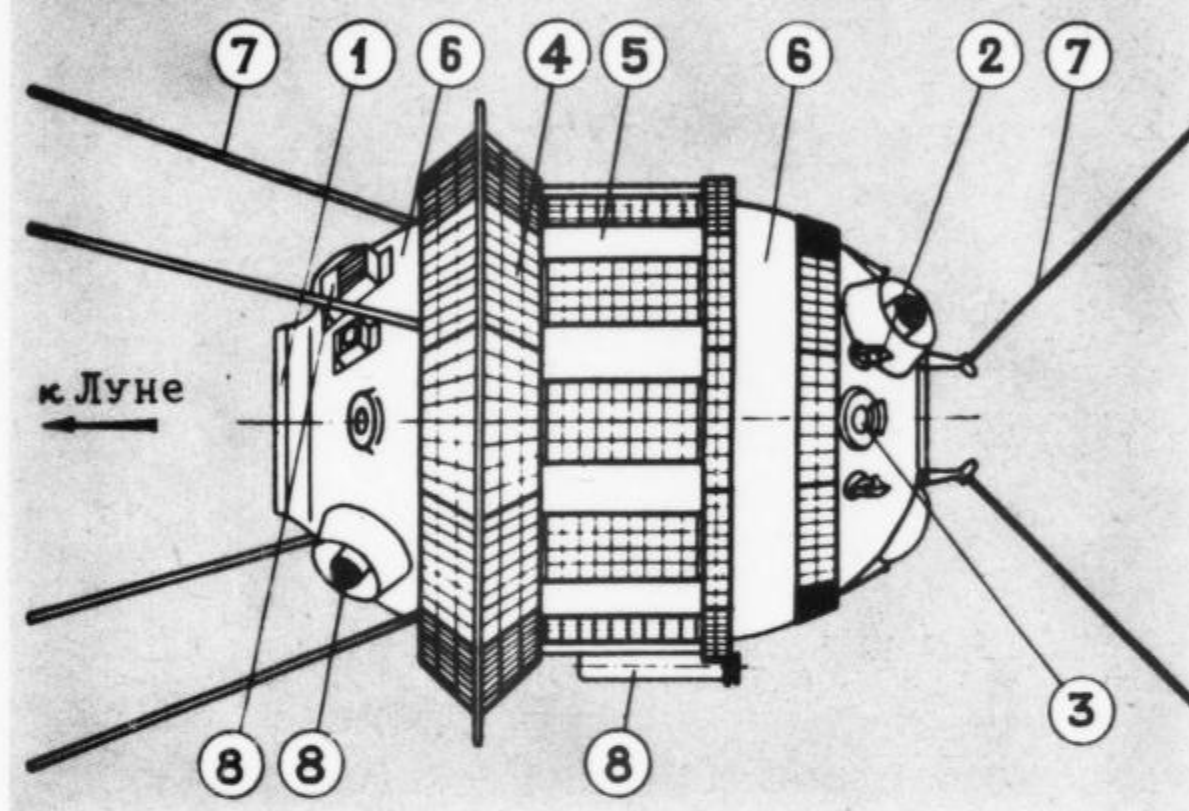
The launching of space rockets and satellites—especially of the Soviet's 5-ton spacecraft of March 9 and 25, 1961—made it abundantly clear that the first of these problems had been solved.

Much of the research our scientists have been carrying on with these vehicles was directed towards the final solution of the other two problems.

Taking the second one, how was the safety of the cosmonauts to be insured? The human organism is rather delicate in space terms and is adapted for living nowhere except in the earth-bound environment. To sustain man's life-cycle functions beyond his planet, an artificial atmosphere with a definite amount of oxygen, a



- | | |
|-----------------------------|-----------------------|
| 1. Illuminator for camera | 5. Thermo regulators |
| 2. Orientation system motor | 6. Thermo screens |
| 3. Solar monitor | 7. Antennas |
| 4. Sun battery section | 8. Radiation monitors |



Fourth Step. Lunik III, which took first pictures of far-side of moon, above, proved out Russian guidance system.



Triumphant Return. Major Yuri Gagarin returns after completing first manned orbital flight around the world aboard Russia's Sputnik XI.

system are the necessities of manned space flight

definite pressure and a proper temperature is required.

Doctors know that at an altitude of 8 kilometers (5 miles), a human being quickly loses consciousness. At the height of 15 km. (9½ m.) he faints within 15 seconds. At the height of 19-20 km. (12 mi.) the air pressure is so low that his blood boils in his veins, even with an oxygen supply provided.

The pressure at the heights of space traversed by satellites is practically zero, and oxygen is non-existent. This means that the interplanetary medium cannot support human life for even a fraction of a second. So, the cosmonaut in space flight must be accommodated in a sealed cabin with an interior environment simulating earth's. It is this kind of air-tight capsule that carried the dog Laika, the first living creature to have traveled into space, in Soviet Sputnik II, Nov. 1957. Similar cabins were installed in our spaceship satellites, starting with Spacecraft I [Sputnik IV] on May 15, 1960, followed by Spacecraft II, III, IV and V [excluding Sputnik VII and the Venus Probe]. The cabins contained a system for air re-oxygenation, carbon dioxide

disposal, and heat regulation.

It is this sort of cabin that was designed for man to make his maiden flight into space. What made the information transmitted from the Sputnik spaceships most valuable is that the temperature and pressure of the air was maintained within the prescribed limits up to a month. Some thought must be given also—in manned space flight—to the possibility of sudden decompression from a meteorite impact, however rare this danger may turn out to be. For that reason, the cosmonaut has to use a special space suit designed to make up for any loss of pressure if the cabin ruptures.

Another serious problem that had to be overcome was the effect inevitably produced by the long accelerations and decelerations of the spaceship's take-off and landing. The spaceship's *steady* speed, however great, has no effect on the organism. It is only a *change* of speed, whether becoming slower or faster, that creates an overload—an additional force which, depending on the magnitude of acceleration or deceleration, may be several times as great as man's normal weight.

(continued on page 54)

CHOOSING THE FIRST



John Glenn



Alan Shepard



Virgil Grissom

A detailed report on selection procedures for the Mercury team

by ERNEST HAUSSMAN

Early in January, 1959, a packet of letters was dispatched from a weather-worn, three-story terracotta building that stands a few blocks from the White House in Washington, D.C. This modest edifice housed—and still does—the headquarters of the newly organized National Aeronautics and Space Administration. The letters, couched in the formal language of government directives, were addressed to the personnel departments of the Air Force, Navy, Marines and Army. They requested dossiers on all available pilots connected with these services who fulfilled a carefully calculated set of requirements:

1. Age less than 40 years.
2. Height less than 5 ft. 11 in.
3. Excellent physical condition.
4. Bachelor's degree (or equivalent).
5. Graduate of test pilot school.
6. 1,500 hours flying time.
7. Qualified jet pilot.

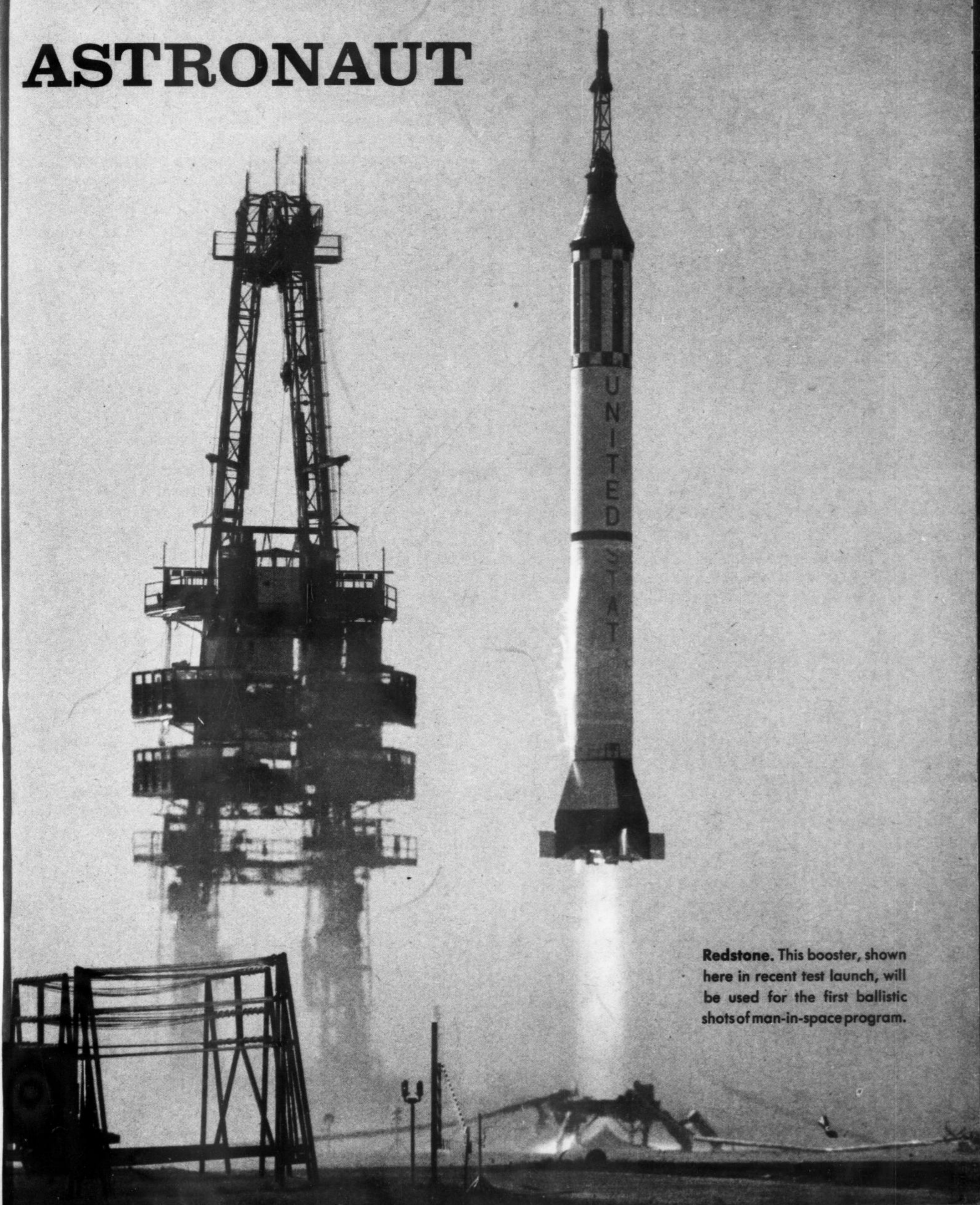
A clerk dropped the letters into a mailbox and in this prosaic manner the most dramatic phase of Project Mercury began. It was the start of the most intensive talent-hunt that America had ever seen. Project Mercury had been assigned the mission of lofting a man into space. The big question was, which man?

Within weeks after the first letters went out, the records of 508 pilots who satisfied the stipulated requirements poured into NASA headquarters. These were forwarded to a team of medical and psychological specialists headed by Dr. Randolph Lovelace, Brig. Gen. Donald Flickinger of the USAF and Capt. Norman Barr, USN. This team was organized for the specific task of choosing our first astronauts. They went over each dossier, minutely studying the records of these 508 men.

(continued on page 18)

T

ASTRONAUT



Redstone. This booster, shown here in recent test launch, will be used for the first ballistic shots of man-in-space program.

Exhaustive physical and psychological tests were used



Capsule Performance. Bundled up in his space suit, John Glenn performs complex operations under launch conditions.

Survival Test. Alan Shepard swelters in desert sun during solitary four-day test of stamina and survival ability.

"There were some arbitrary criteria in the initial screening," said Gen. Flickinger, "that had to do with educational background, height, intelligence and medical-history background. The height limit of 5 feet 11 inches, for example, was irrevocable because it was governed by the dimensions within the capsule."

To this Capt. Barr added: "These men also had to have a technical background in the subjects related to this new specialty. Besides being qualified test pilots, they had to know some astronomy, physics, mathematics and other basic sciences."

From the beginning, it was realized that there were three crucial criteria for selecting the astronauts: physical, psychological and technical. And, contrary to general opinion, the most important single factor was technical training and competence.

At no time was consideration given to throwing Project Mercury open to volunteers. Psychologists pointed out that many men who would blindly volunteer to be fired into space would also show evidence of serious mental instability. After much deliberation, those charged with the job of selecting the astronauts decided instead to pre-select a rather small group from which volunteers would be sought after having had the program carefully explained to them.



to screen Mercury volunteers

Obviously many thousands of Americans might have qualified both physically and psychologically. Press notices notwithstanding, the astronauts never have been held up either as supermen or geniuses. They are highly select physical and mental specimens; but so are a good many other American men. Therefore the really crucial point on which their selection depended was technical competence.

Dr. Robert Voas, one of the psychologists attached to the project, explained it this way: "We were looking for a professional group that already fulfilled many of the requirements necessary to enable us to achieve manned space flight *at the earliest time*. This criterion brought us inevitably to test pilots. Others could undoubtedly have been trained, but these men had a tremendous head start in the most important factor of all—technical skill."

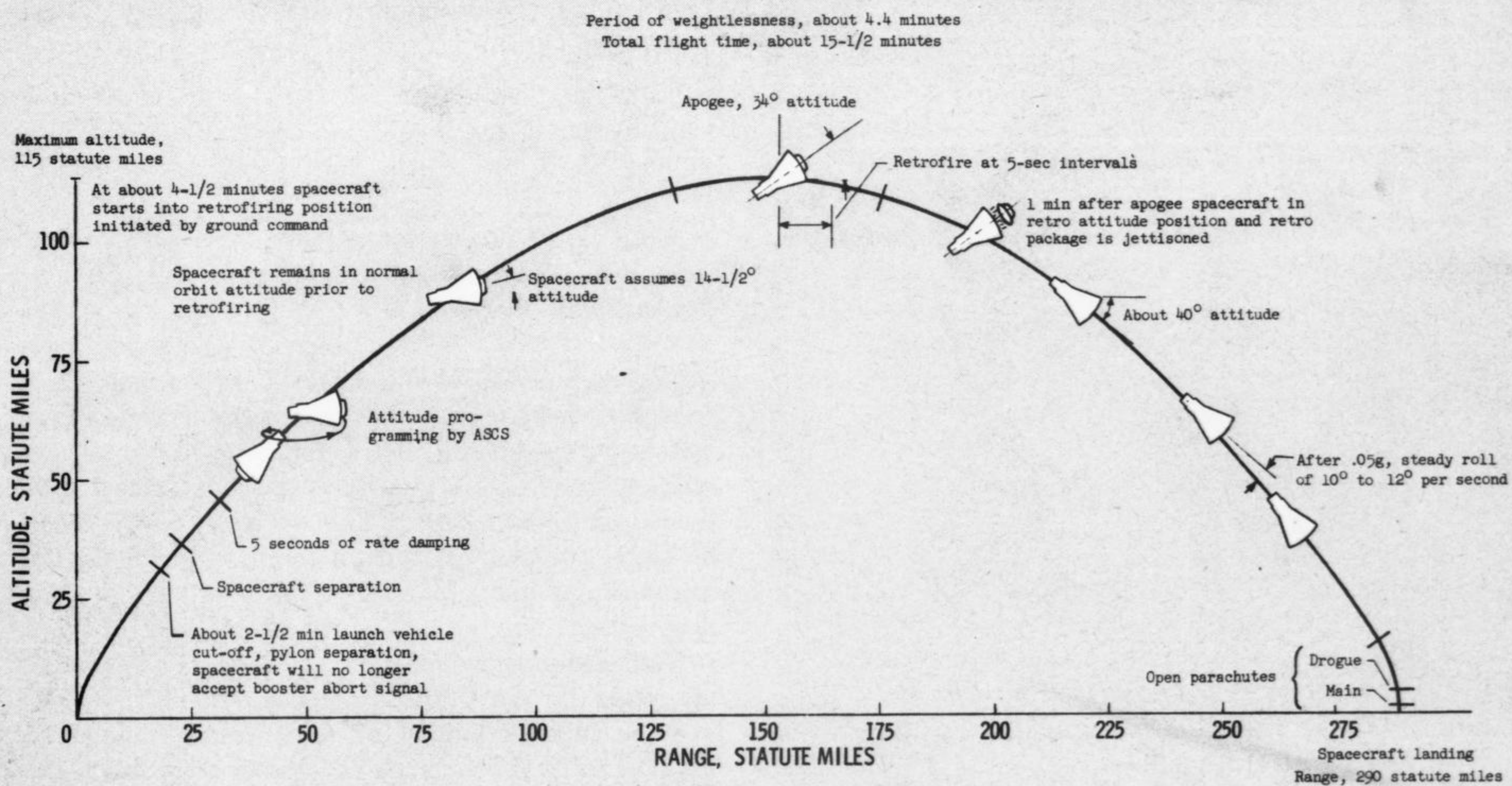
Thus, even before the gigantic talent-search started, consideration was limited to test pilots whose unique technical skills were matched by rigid physical and psychological requirements that were established by the selection team. But, there were almost as many civilian test pilots as there were military.

Again, an arbitrary criterion was established. Civilian

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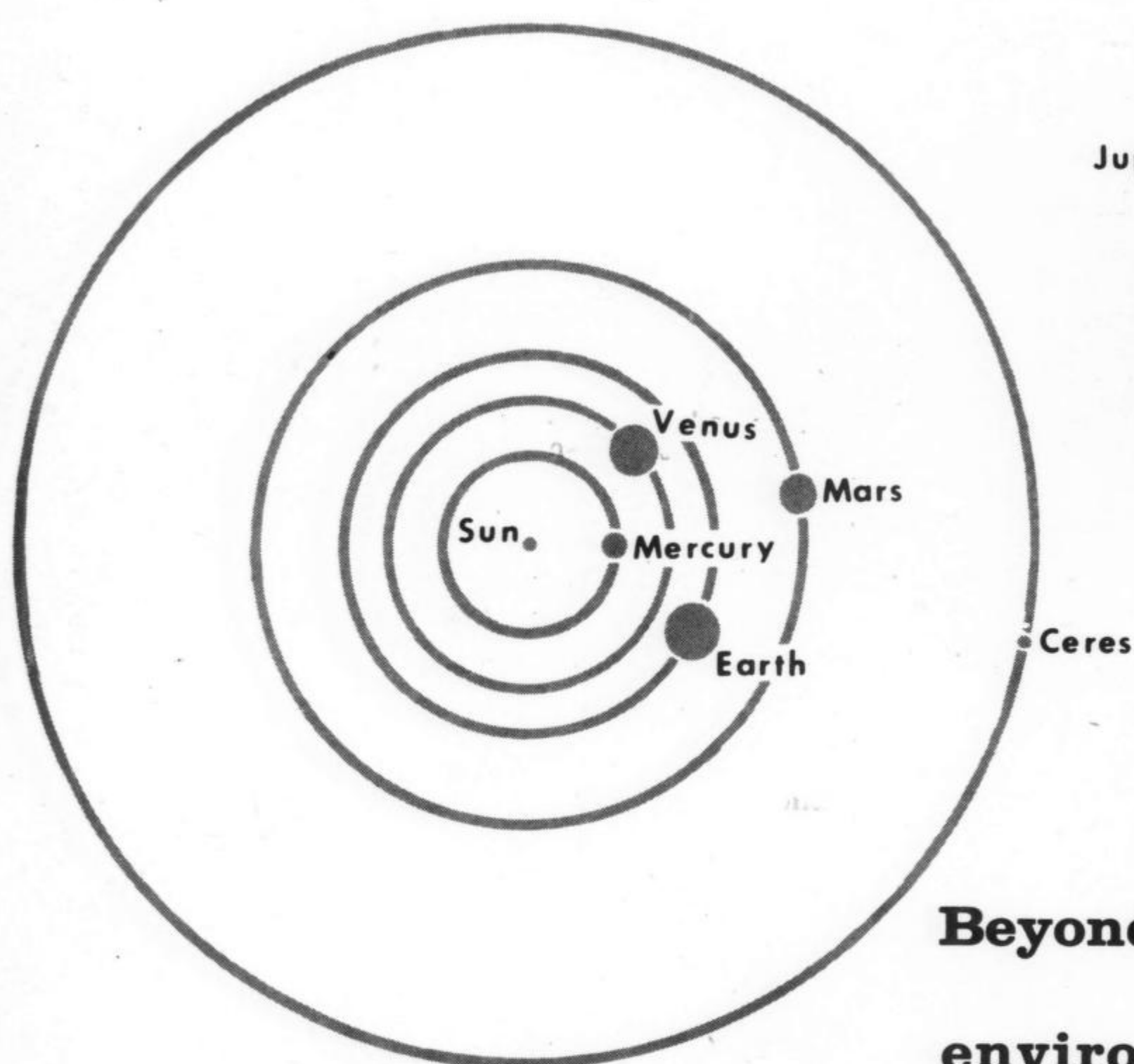
Motor Dexterity. Virgil Grissom's ability to function under adverse conditions is tested in a high-altitude simulator equipped with testing panel.



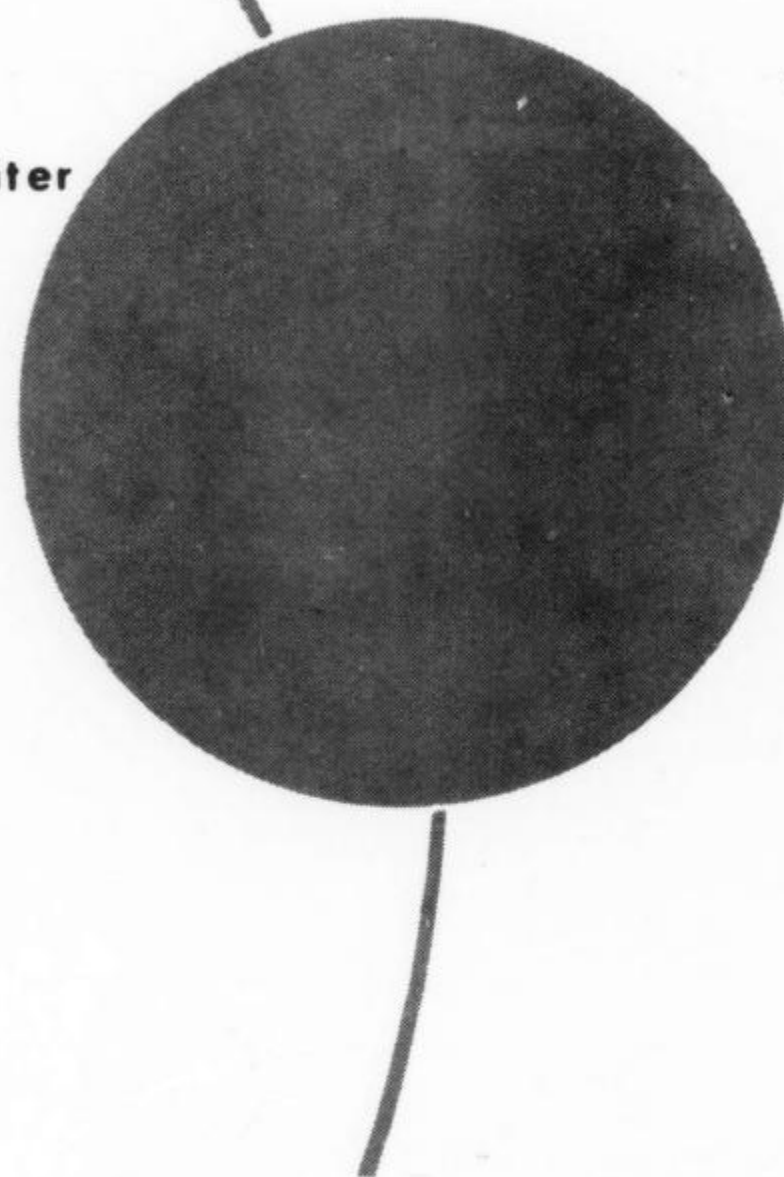
Normal sequence of events for Mercury-Redstone flight

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EXTRATERRESTRIAL



Jupiter



Beyond Mars, increasingly hostile environments face our colonists

by OTTO O. BINDER

When we have finally succeeded in establishing permanent manned outposts on both the moon and Mars, where will our colonists next find planetary abodes?

The answer, based on our present knowledge, is a toss-up. Venus and Mercury seem most likely to be visited early by manned expeditions since these planets are comparatively near earth. But the asteroids beyond Mars and even the moons of Jupiter could become targets for exploration and settlement at about the same time.

After the moon and Mars, none of the solar system bodies has any particular advantage over the other. Which will prove suitable or desirable as colonies will depend on factors presently unknown. Considering heavenly bodies in the order of their nearness to earth, our first subject is Venus.

Venus is three worlds — in theory at least. Because its surface is always shrouded from telescopic view,

astronomical opinion is more divided about conditions on Venus than on any other planet or body. One camp believes that Venus is a bone-dry desert world. Another group claims Venus is covered by water from pole to pole. These Wets and Drys are challenged by a third group who subscribe to a theory prevalent in the last century—that Venus is a dry-and-wet world similar to earth, perhaps with comparable environment and life forms, both plant and animal.

Scientists have been able to examine (with the spectroscope) only the top layer of clouds that surround Venus. They find this portion of its atmosphere to consist mainly of carbon dioxide with traces of nitrogen, oxygen and water vapor. Most authorities concede that spectroscopic examination reveals nothing of the lower air of Venus which may be oxygenated and moist. British expert Felix Godwin says, "If this is the case, there is no reason why life of sorts should not exist on Venus." Dr. Heinz Haber speculates that a sort of

BASES #3



Asteroid Landing. Artist's drawing shows a landing party on an asteroid in orbit between Mars and Jupiter.

aerial "plankton", preyed upon by flying creatures, may float in the heavy Venusian atmosphere.

Housing

Venus is the earth's "sister" in general size and surface gravity. The Venus day however, is generally believed to be weeks long. The surface temperature cannot be much less than the boiling point of water and is perhaps higher. The sea-level pressure of its massive atmosphere might make earth people uncomfortable and force them to wear anti-pressure suits.

This greater-than-earth air pressure would mean that any plastic housing filled with earth-thin air, and not anchored down, would float upward like a hydrogen-filled balloon. Godwin suggests that if Venusian air contains suffocating amounts of carbon dioxide and poisonous fumes such as carbon monoxide, the doorway into the colony would not be an air-lock but a "water-lock". Colonists arriving on Venus would have

to swim through a water tank which keeps the outer gases from seeping into the interior.

We could cope with conditions on Venus with our present environment technology only if both the Wets and Drys are wrong and the Wet-Drys are right.

If Venus is totally arid, as the Drys maintain, the problems of colonization would be enormous. And if, as the Wets think, it is one tempestuous sea from pole to pole, it might also be shunned by the hardest of settlers.

Time, and Venus probe investigations, will probably tell the tale although there is a possibility that probe borne radar, ultra-violet and infra-red scanners will be unable to pierce the Venus veil to examine the surface. In this case, we may have to wait until payloads can be soft-landed on the Venusian surface to find out if mankind has gained a colony—or lost a world.

Colonists looking for a place to spend years or to remain permanently may shun Mercury for a long time.

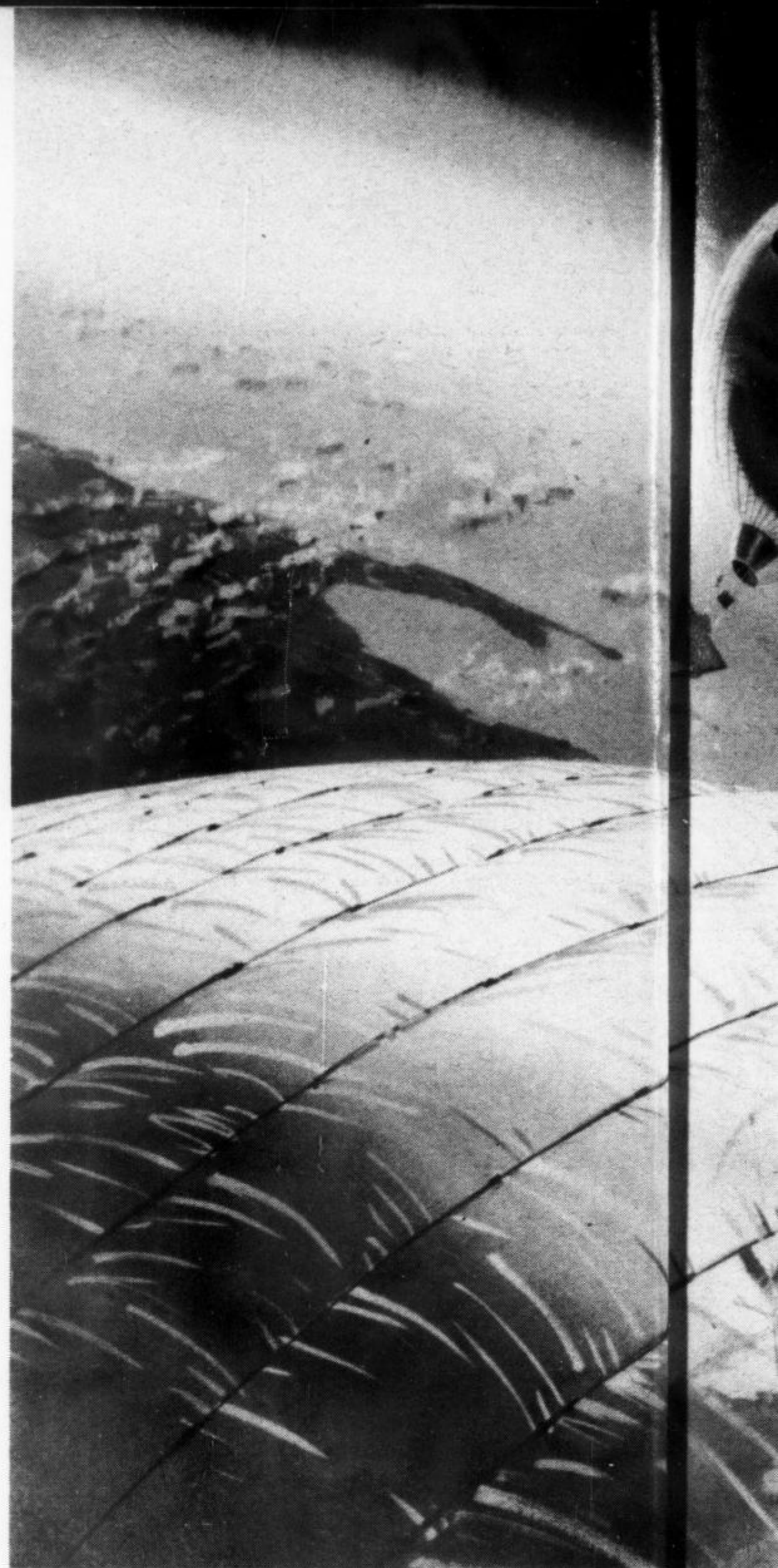
(continued on page 46)

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INFLATABLE SPACE VEHICLES

by ROBERT GRANVILLE

**An examination of the new family
of satellites that began with Echo I**



If anyone had suggested 10 years ago that "balloons" could have a use in airless space as substitutes for metallic vehicles, he would have seemed as light-headed as a helium-filled balloon.

But after August 12, 1960, his suggestion would have won him acclaim as a space oracle.

On that date, an aluminized Mylar plastic sphere 100 feet in diameter (Echo I) became the first American satellite visible to the naked eye, and excited millions watched this starlike radio-relay device meander among the constellations.

Before Echo I had made a few dozen revolutions around earth, teams of engineers were starting work on a whole line of other inflatable space vehicles. NASA, Lockheed, General Electric, Goodyear, Martin—everybody wanted to get into the act. At least a dozen types of expandable space vehicles and devices have come forth in the past 10 months since the debut of Echo. Several factors weigh heavily in favor of increased use of these inflatables in our space program. A few are:

1. An inflatable structure made of thin plastic weighs far less than a similar vehicle made of even the flimsiest

metal skin, thus solving payload problems with marginal boosters.

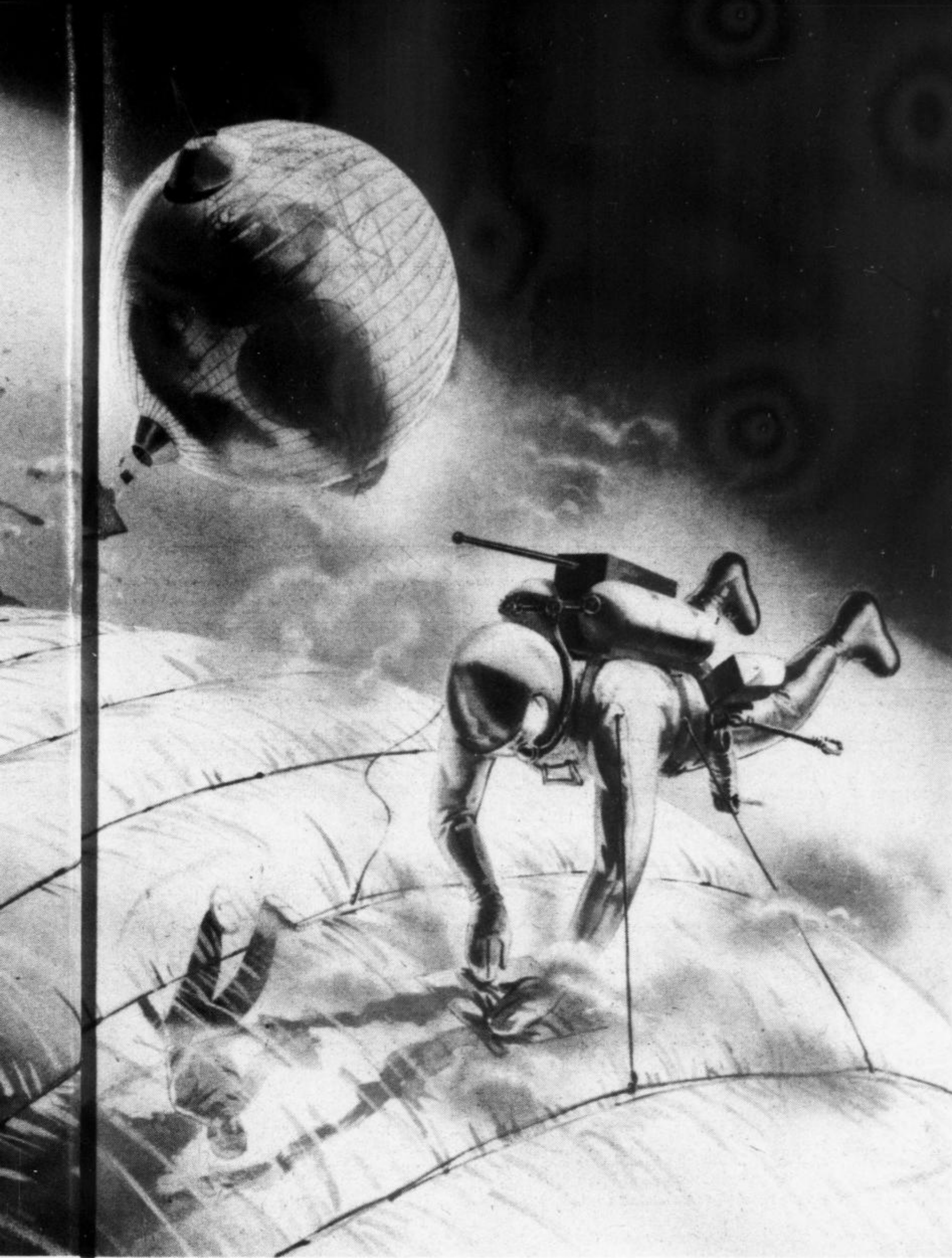
2. Like a parachute, a flexible device designed to be inflated in space can be folded and packed into a small area. Thus an inflatable satellite can be much larger than any pre-formed rigid type that has to be boosted in its original bulky form.

3. Costs of the inflatable craft are far lower than comparable metal vehicles because of the relative cheapness of plastics.

4. Almost any imaginable kind of odd-shaped craft can be lofted to blossom out beyond the atmosphere, whereas rigid satellites have to be restricted to a few basic conventional forms.

Inflatable Researches

Among the proposed inflatable structures now being studied and designed are: 1) drag devices for the re-entry of unmanned vehicles; 2) solar power reflectors; 3) erectable antennae for satellites; 4) recovery systems for boosters; 5) re-entry gliders for manned craft; 6) manned re-entry vehicles; 7) space stations; 8) space



Inflatables. Artist's concept, left, shows large earth-orbiting balloons that would contain controlled atmosphere enabling technicians inside to work without wearing space suits. A. Antuchin, RCA engineer, above, demonstrates model of an inflatable antenna designed for satellite telemetry.

drydocks for repair and maintenance missions; 9) spaceships; 10) extraterrestrial housing for space explorers.

All of these will require reinforced plastic or rubberized skins flexible enough to inflate easily in space and remain rigid after that. In short, they have to be "one way" balloons—able to inflate but not deflate. Several firms, as well as NASA, are researching various materials. The original Echo skin was Mylar plastic $1/5,000$ of an inch thick—thinner than the cellophane around cigarette packs—coated with a molecular layer of aluminum. (See offer at the end of this article).

Internal sublimating powders heated by the sun formed the gases that expanded the gigantic balloon in orbit. After inflation, the aluminum coating acted as a thin metallic shell to prevent deflation. This concept proved more successful with Echo than had been expected. When Echo passed into earth's shadow, NASA scientists believed it might collapse as its sublimated gases froze. But Echo held firm. Nor did micrometeorite punctures, which let most of the gases leak out after Echo's return to sunlight, cause the satelloon to deflate.

Somewhat wrinkled, and a bit lopsided from unequalized vapor pressures within, Echo, now a nearly gasless gas-bag, is still circling earth. It has an estimated life of 2 to 15 years. At its launching, NASA dared predict only a year of life at the most.

Even tougher and more rigid fabrics are now being devised. Goodyear's engineers are working on Airmat, a double-walled plastic container. Plastic foam will be blown between the walls so that a hard stiff structure will form in space. They are also developing a sandwiched fabric of finely drawn wire mesh, covered with layers of silicone elastomer plastics and glass enamel, which will resist re-entry temperatures up to 1,500 degrees F.

General Electric's scientists are researching a unique "foamed-in-place" process, whereby two reactants are released in space to combine chemically and form a rigid plastic shell around a flexible mold.

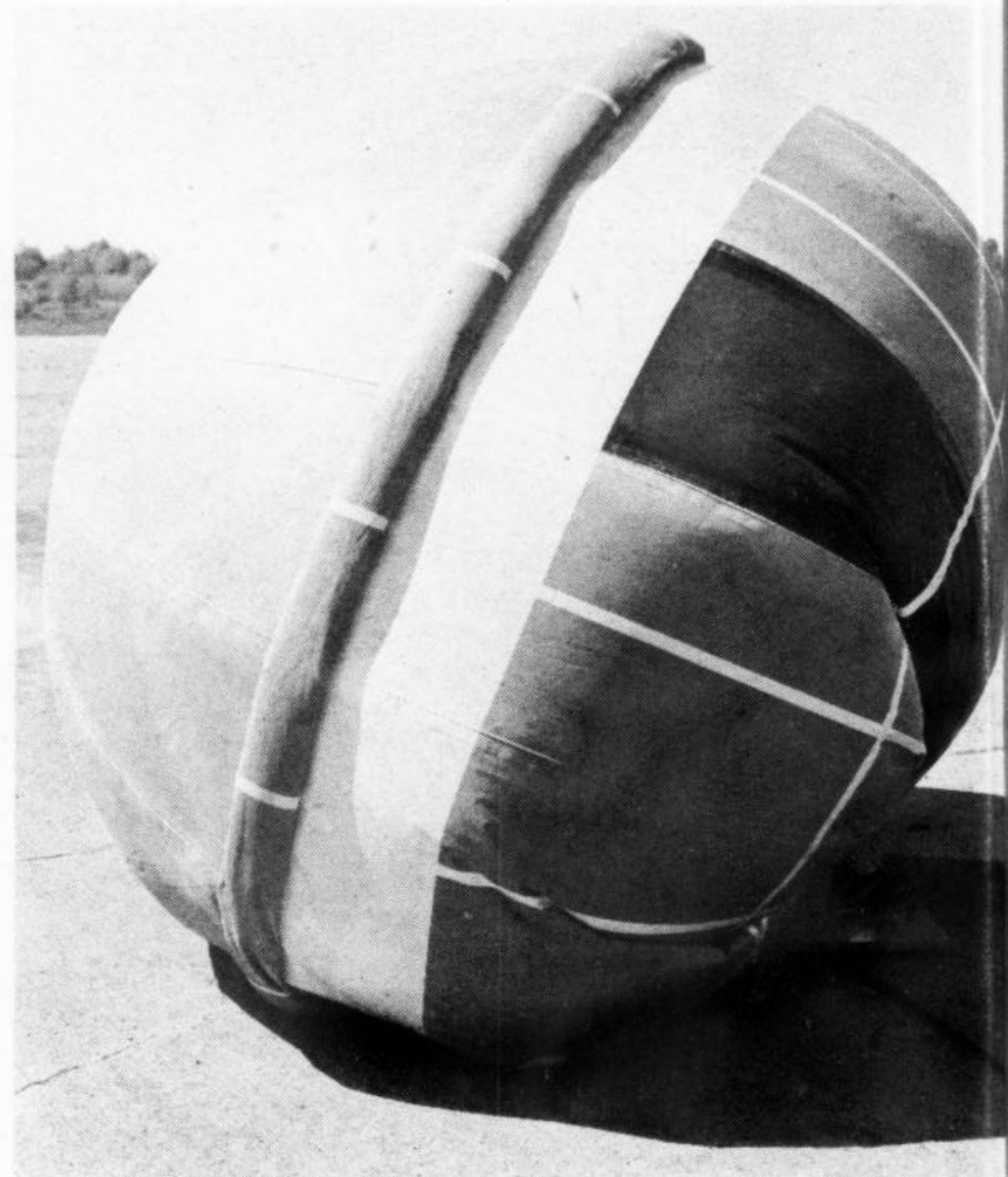
The methods of inflation are also undergoing intensive study. New sublimating powders, evaporating liquids, or compressed gases of many varieties are being tried. Goodyear's engineers have worked out an inflation sys-

(continued on next page)



Lightweight, easily packed

and



Re-entry Drag Balloon

Coated fabric drag balloon capable of inflating in one-tenth of a second is shown in packaged, semi-inflated and inflated stages. The device is designed to control the high-speed deceleration of manned and un-manned vehicles by creating a maximum aerodynamic drag.



ked and sturdy, inflatables offer space engineers a new challenge

tem that will blow up a 12-foot balloon in 1/10 of a second flat.

Techniques for developing more and more rigid materials are also taking many other forms as research goes on. Engineers at the G. T. Schjeldahl Company, creators of Mylar spheres for NASA, are studying photochemical processes, solar radiation effects, and electrostatic charges on plasticized metal foil, to obtain non-collapsible space vehicle hulls.

Forms and Missions

Since Montgolfier invented the balloon in 1783, lighter-than-air flying craft have assumed a variety of forms and missions. Some of these are the zeppelin, non-rigid and rigid blimps, weather balloons carrying instruments to high altitudes, and huge gas-bags with manned gondolas beneath.

But the new breed of space balloons will be far more diversified. Referring to our previous list and taking them in order:

Drag Devices. NASA scientists are investigating methods of packing deflated objects along with the recoverable payloads that are placed in orbit. Upon re-entry an auxiliary "wing", attached above the returning payload, inflates to provide a wide surface area sensitive to the slightest air-drag in the rarefied upper regions. This will slow down the payload from orbital speed much more rapidly than would any known parachute system, and will also eliminate excessive re-entry heat for the vehicle being recovered.

Goodyear technicians have developed the "ballute", a round balloon having the same purpose as NASA's drag device, and have already delivered small payloads sent up in research rockets. Though the ballute was subjected to speeds which were below orbital, Goodyear's engineers believe a refractorized ballute can be designed to withstand the enormous air-frictional heat produced when objects return from orbit at 17,500 mph. The orbital ballute, after popping out during re-entry maneuvers, will hang on unbreakable strings with the payload dangling below. As both objects plow into thicker air, the ballute's air-drag will mount to high proportions and swiftly cut speeds.

Solar Reflectors. Engineers are also planning inflatables which will unfold as huge, undistorted dish-shaped reflectors when the satellite reaches orbit. The surface, becoming taut and properly curved, will be covered with a bright metal foil to catch the sunlight. This plastic sun-mirror will then perform like a metallic dish collecting solar-power for a generator system.

The engineers at Goodyear believe they can eventually devise inflatable bowls, 100 feet wide, to collect



Inflatable Antenna. Technician demonstrates light-weight characteristic of inflatables that adapts them for space use.

radiant energy for large manned orbiters, moon ferries and interplanetary ships.

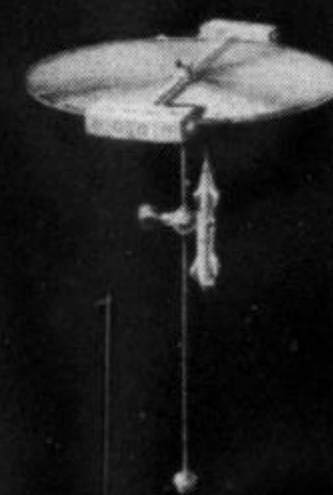
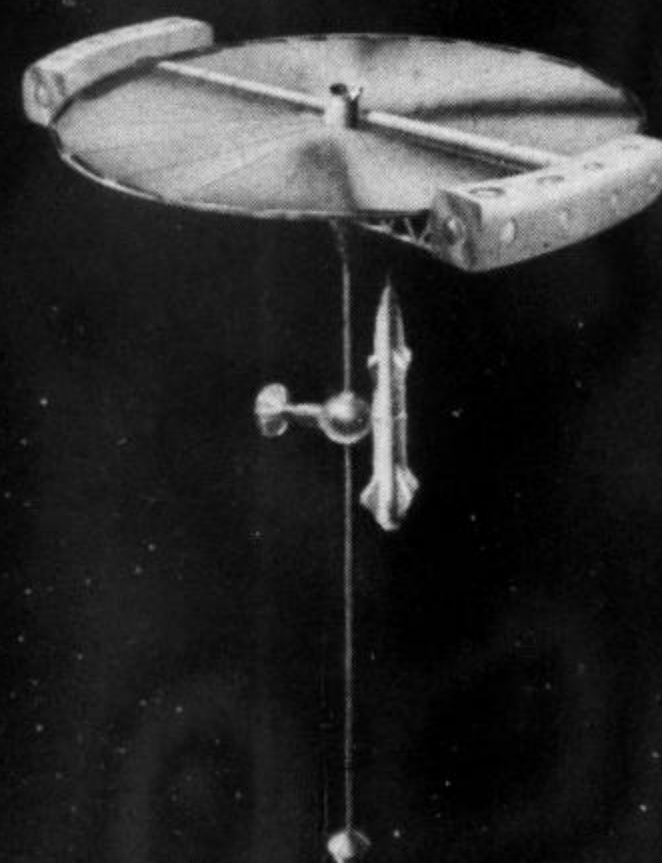
Personnel at General Electric Missile and Space Vehicle Division are at work on aluminized Mylar mirrors for conversion of sunlight to electricity in powering systems suitable for all kinds of vehicles. To increase the balloon-dish's useful life against meteorite penetrations, a plastic foam that "seals itself"—somewhat like puncture-proof auto tires—would be pumped within the mirror's double walls.

Erectable Antennae. Lockheed engineers are especially concerned with designing various shapes that can unfold in orbit where their metallized outer skins will serve as receiving and transmitting antennae.

They have found that thin aluminum foil by itself, without any plastic backup, can be designed in a pressurized, flat, rolled-up form which will unfurl as long cylindrical tubes. In space orbit under zero-g conditions, the paper-thin foil is as sturdy as sheet steel.

Another antennae system uses plastics combined with aluminum foil which will unfold on top of a satellite

(continued on page 56)



Mars Mission. Ion engine will prove its practicality on long-range missions.

JOBS FOR THE L

INDEXED BY P.A.L.

by **ERNST STUHLINGER**

If you want to move from one room to the next, your best choice of transportation is your legs. You take a car to the supermarket, and an overnight train if you're travelling from Washington to Boston. A jet plane is probably the fastest mode of transportation between California and the east, but it is far cheaper and far more satisfactory to ship a heavy piece of equipment from Philadelphia to Los Angeles by boat.

It would be illogical to eliminate any of these methods of transportation. Each has its use and is by far the most efficient solution to a particular transport problem. Among flying vehicles, for example, we find balloons, helicopters, propeller and jet driven planes.

The same holds true in the realm of rocket transport. That is why it is unrealistic to speak of one type of rocket system superseding another. We hear that the nuclear rocket will replace the chemical; that the solid-fuel booster is superior to the liquid, or vice-versa; that

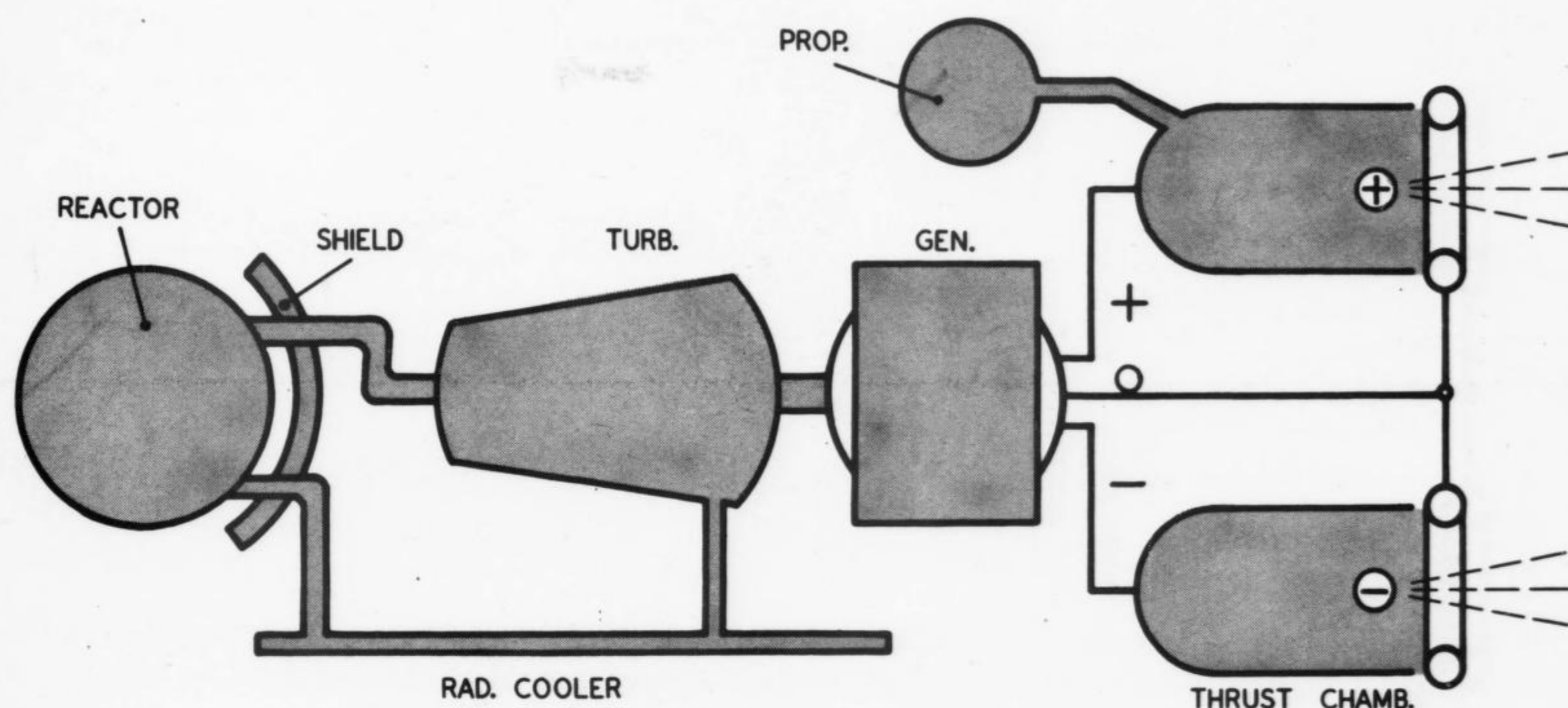
low-thrust ion-engines will make all other rocket modes obsolete. Actually, all of these techniques will contribute to the conquest of space.

The chemical rocket has already proved its usefulness in launching satellites and probes beyond earth's gravitational pull. It has the advantage of generating enormous thrust, but because this thrust is the function of a chemical reaction, it has the disadvantage of a limited exhaust velocity. The chemical rocket cannot accelerate its payload beyond the limits of its exhaust velocity without using prohibitive amounts of fuel. We realize that this factor places a severe limitation on any extended deep-space operation.

We must look for alternatives to supplement the chemical rocket. One of the most promising techniques that is currently being explored—the ion-drive—offers some intriguing possibilities for a solution to this problem.

An ion is an atom that has lost one of its electrons, causing it to become electrically charged. We know that

A distinguished member of Wernher von Braun's staff discusses the capabilities of the Ion engine



Schematic shows basic ion engine components.

LOW-THRUST ENGINE

these charged particles can be accelerated to enormous velocity by a magnetic field. This characteristic is what intrigues the investigators. But we also know that because of the mutual repelling force which the particles generate on each other (like electrical charges repel), the density of flow of the ions will always be small.

Thus, we find the ion-drive creates a situation exactly opposite to that of the chemical rocket. The latter generates huge thrust with limited velocity, while the ion-drive generates enormous velocity with severely limited thrust.

Actually, the principle of the ion-drive has been known for some time now. In September, 1906, Robert H. Goddard, who was experimenting with electrically charged particles at that time, noted that they might be useful for rocket propulsion. Twenty-three years later, Hermann Oberth devoted a chapter of his book *Wege zur Raumschiffahrt (Methods of Interplanetary Travel)* to electric propulsion.

Then, in 1946, J. Ackeret, a Swiss scientist, developed

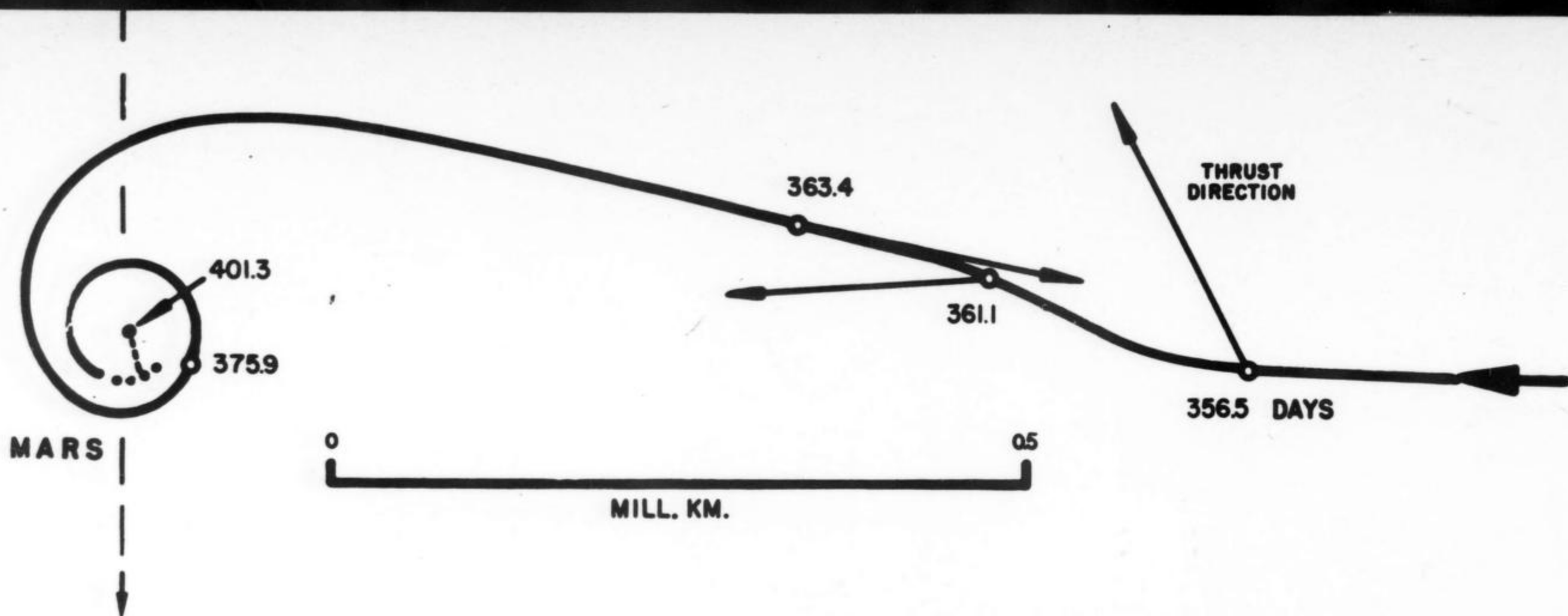
a general theory of propulsion which was applicable to ion rocket engines. After Ackeret, papers on electric propulsion became more frequent. Shepherd and Claver, in England, coined the term "ion rocket" and Forbes, Lawden and Spitzer calculated trajectories of space vehicles powered by ion engines.

With the theoretical basis for the ion-drive firmly formulated, work began on the actual construction of working models of an ion engine. During the past five years, many encouraging laboratory experiments have been carried out and both NASA and private concerns are supporting research and development work on the ion engine.

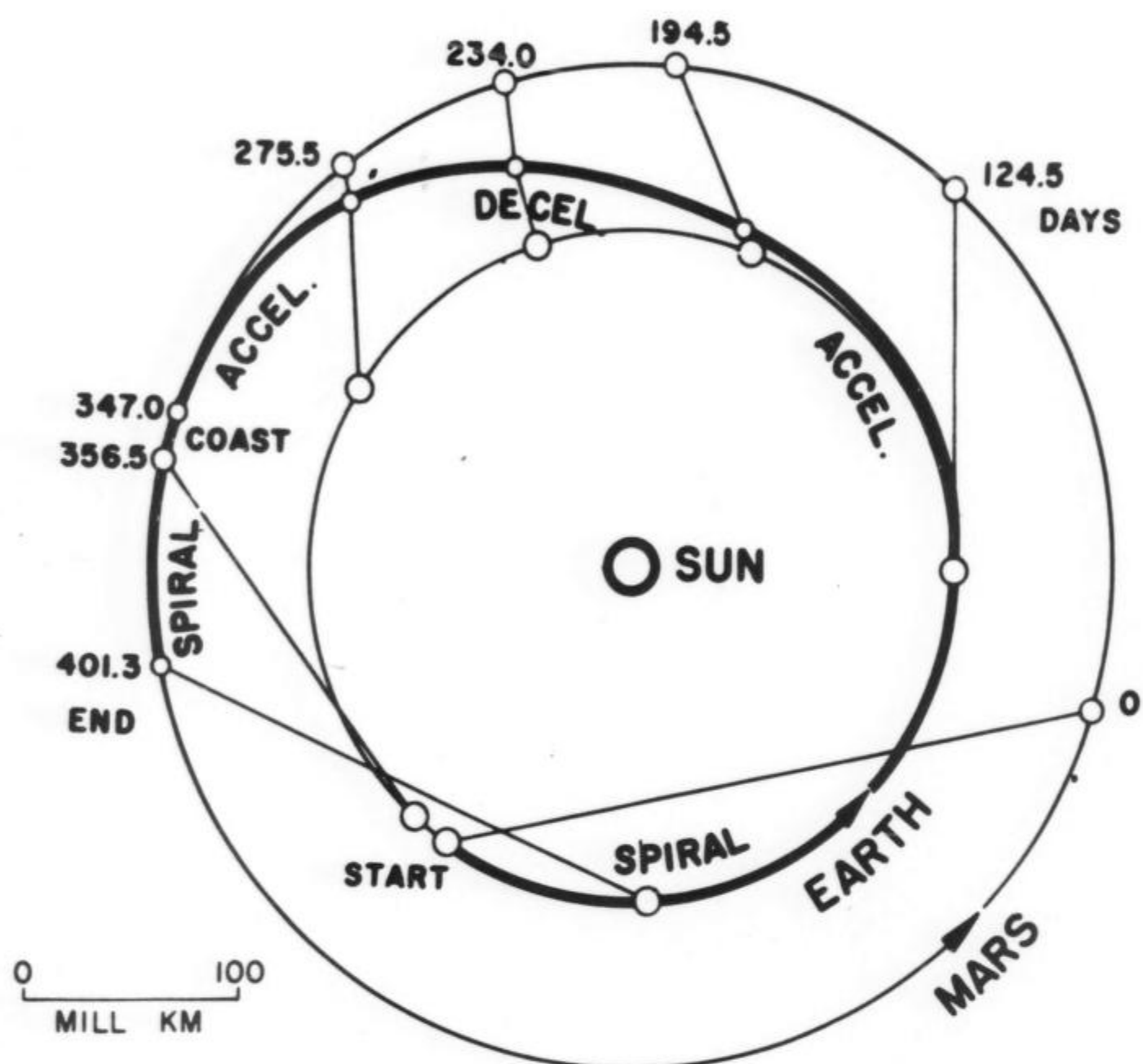
The fundamental distinction of the ion-drive is its high exhaust velocity combined with a low rate of mass flow. The question now is how will we be able to best utilize this unique capacity?

The first thing we must take into account when considering ion propulsion is the low thrust factor. If the

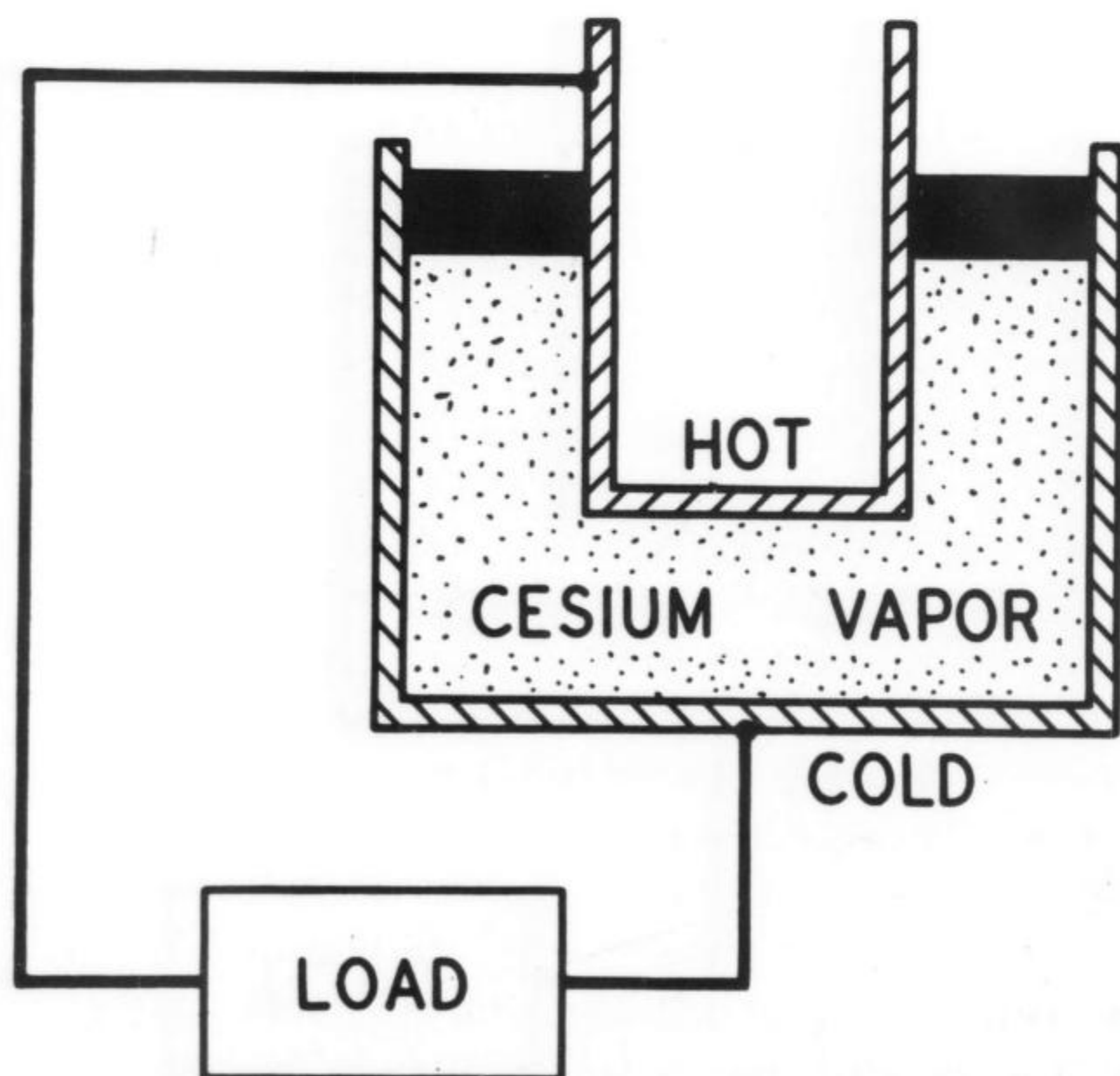
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Mars Trajectory. Ion propulsion, operating continuously, will simplify navigation because adjustments can be made at any time.



Circular Journey. Chart, above, shows minimum energy path between earth and Mars, and relative positions of the two bodies.



Thermo-Electric Unit. Simplified drawing shows unit that could change heat into electricity without a mechanical generator.

First task for the Ion system

system is to produce any sizable terminal velocity, we must allow for a long operating time. In fact, ion drives will be useful only under circumstances where low acceleration and weeks or even years of propulsion time are acceptable.

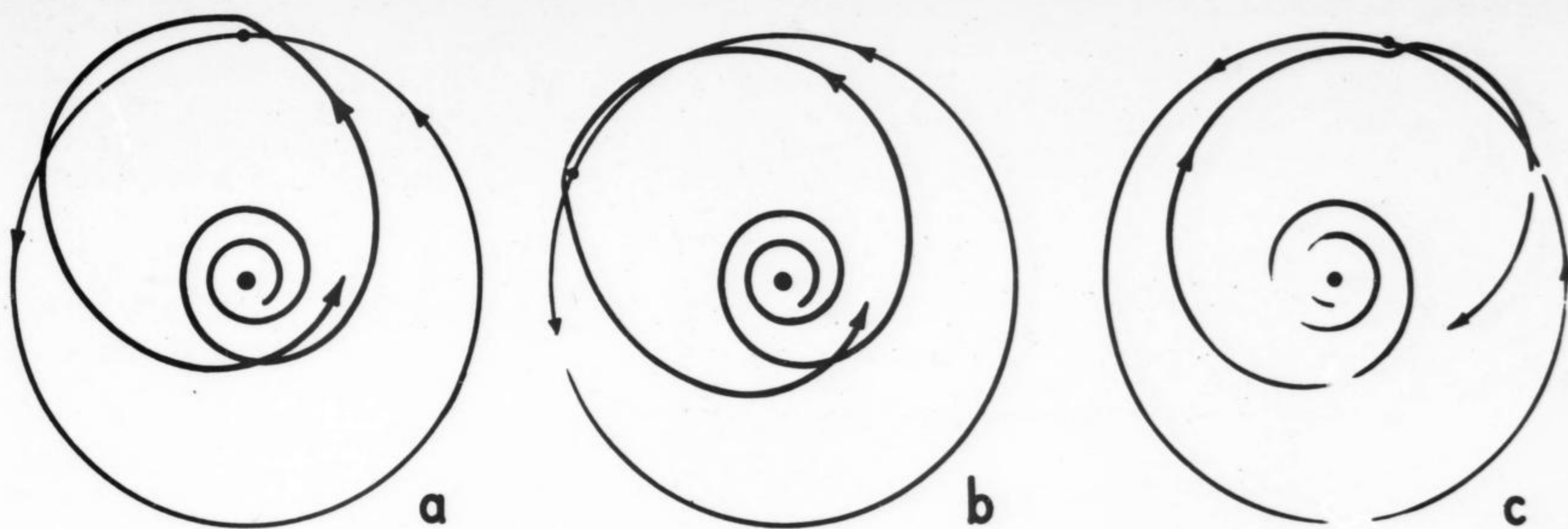
Such circumstances will indeed exist in future space missions. Application of the ion drive, however, will remain limited to the space beyond any appreciable atmosphere, as the ion drive does not have the brute thrust to lift a payload from earth at zero velocity.

Keeping these factors in mind, let us consider some of the tasks that this system can undertake in space exploration. The ion-drive can fulfill the need for a light, small, low-thrust propulsion until that will apply minor corrective forces to keep satellites on a prescribed orbital path with high precision over a long period of time.

The superiority of an ion system over a chemical or even a compressed gas system for satellite orbit control, begins when the total velocity corrections, generated over the active life of the satellite, amount to about 300 feet per second or more. If less total velocity change is required, chemical or jet gas systems will be more efficient.

As time goes on, our earth-bound communication systems will prove more and more inadequate. It is possible that someday the altitude of the 24-hour satellite (22,300 miles) will be a region abounding with heavy communication equipment installed and operated by civilian telephone and telegraph companies. Here we find another role for the low-thrust engine.

While two or three-stage chemically propelled vehicles can place heavy loads into low orbits of a few hundred miles altitude, it takes a powerful and sophisticated multi-stager to put even a modest payload into the 22,300 mile orbit. On the other hand, a low-thrust ion system will lend itself readily to raising a heavy load



Paths For Lunar Approach. A) approach from the rear. B) the direct approach. C) counter rotating orbit. All three of these

trajectories will be accomplished by the use of low-thrust high-velocity ion propulsion systems which are now under study.

will be the lofting of payloads from low to high orbits

from low into high orbit when speed is not a decisive factor.

Beginning operation in low orbit, the ion drive would push the load along a spiral path, while gradually changing its orbital plane to that of the high orbit. Finally, it would adjust the payload to the desired altitude. Having completed this mission, the electric engine system would detach itself from the payload and return on a steep spiral to low orbit, where its cesium propellant could be replenished by maintenance vehicles, so that it would be ready to haul another big package into the high orbit.

On the basis of our previous assumptions (150 watts per pound), this space-lift system may have the following capabilities: a payload package of 50 tons could be transported from a 650 mile orbit into a 22,300 mile orbit in about 23 days, with a propulsion system weighing only 22 tons. The return trip of the "tow truck" would take 6 days. The power plant of the system would develop 4.5 megawatts of electric power.

The vehicle would be guided by a combination of inertial and radio command components. It would be unmanned, but the loading of new propellant and payload in low orbit would be done with human assistance.

One challenging mission for this space-lift system might be the transfer of an inhabitable 24-hour satellite into high orbit, after its assembly in low orbit. The human crew would make the trip in a small, but fast, chemically propelled vehicle, in order to avoid excessive exposure to the Van Allen radiation.

The next logical extension of the ion space-lift will be the ferrying of heavy payloads to the moon. Again, chemical systems can make the trip faster but they are severely limited in payload capability.

A typical ion-drive moon ferry may have the follow-

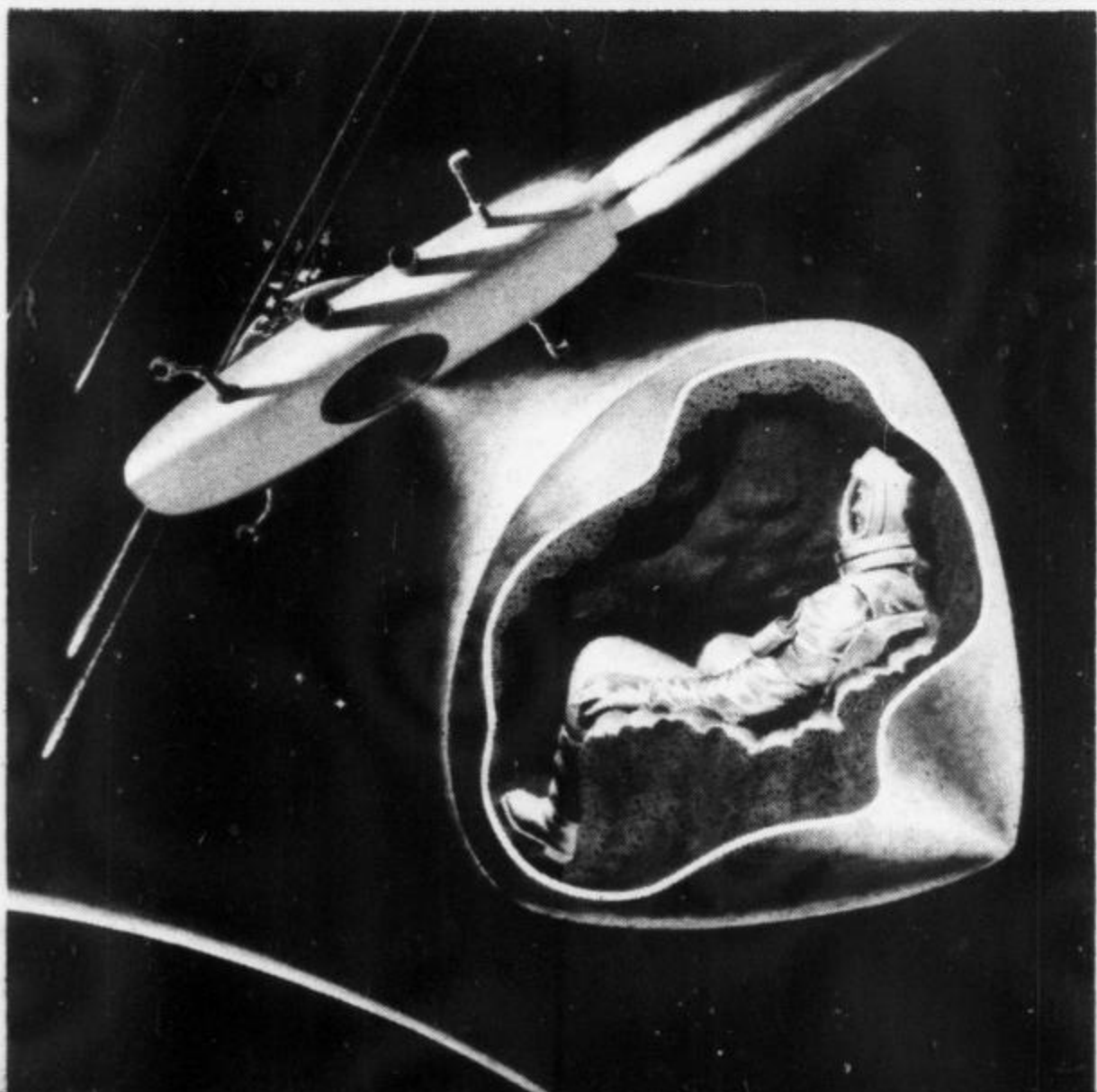
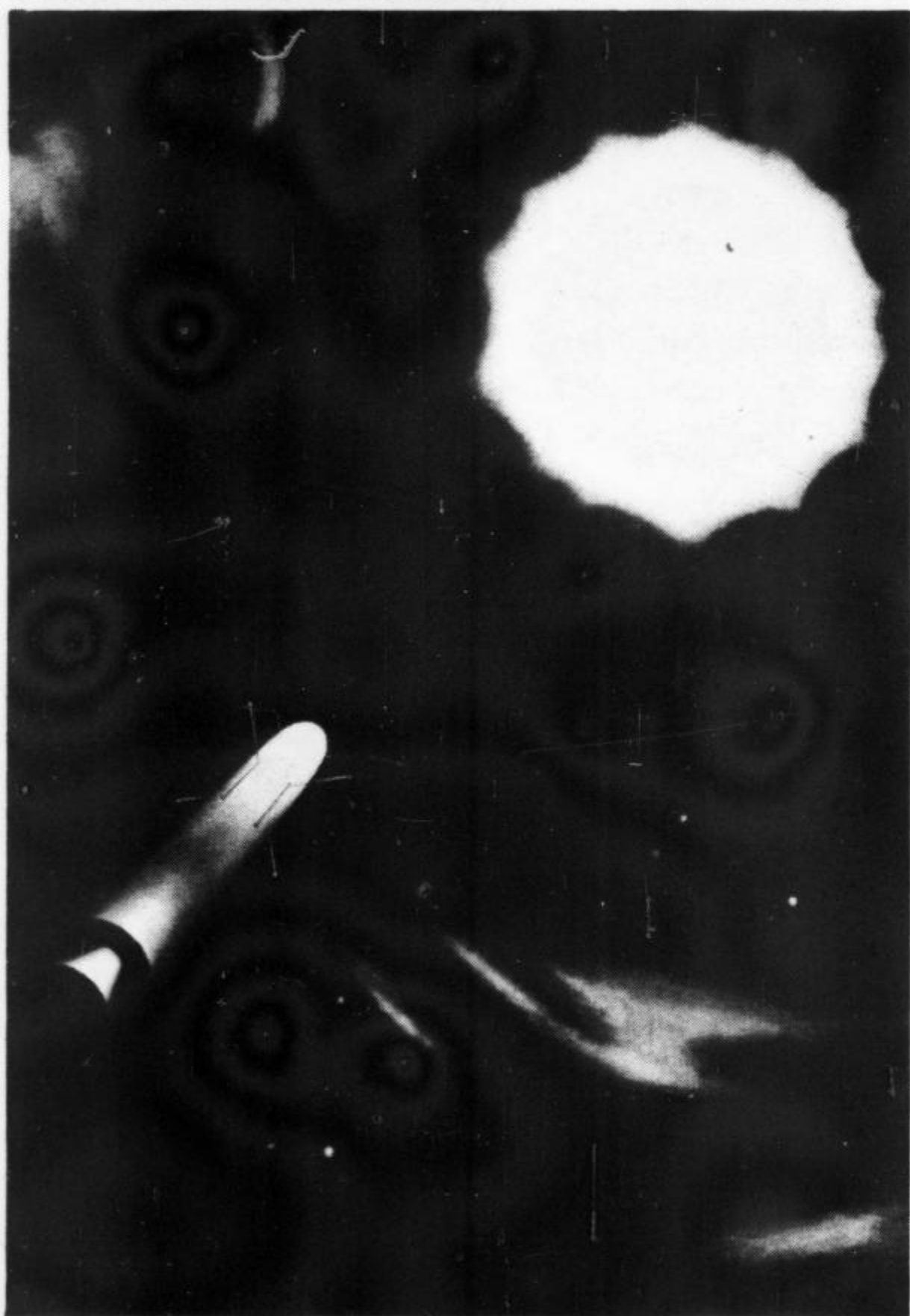
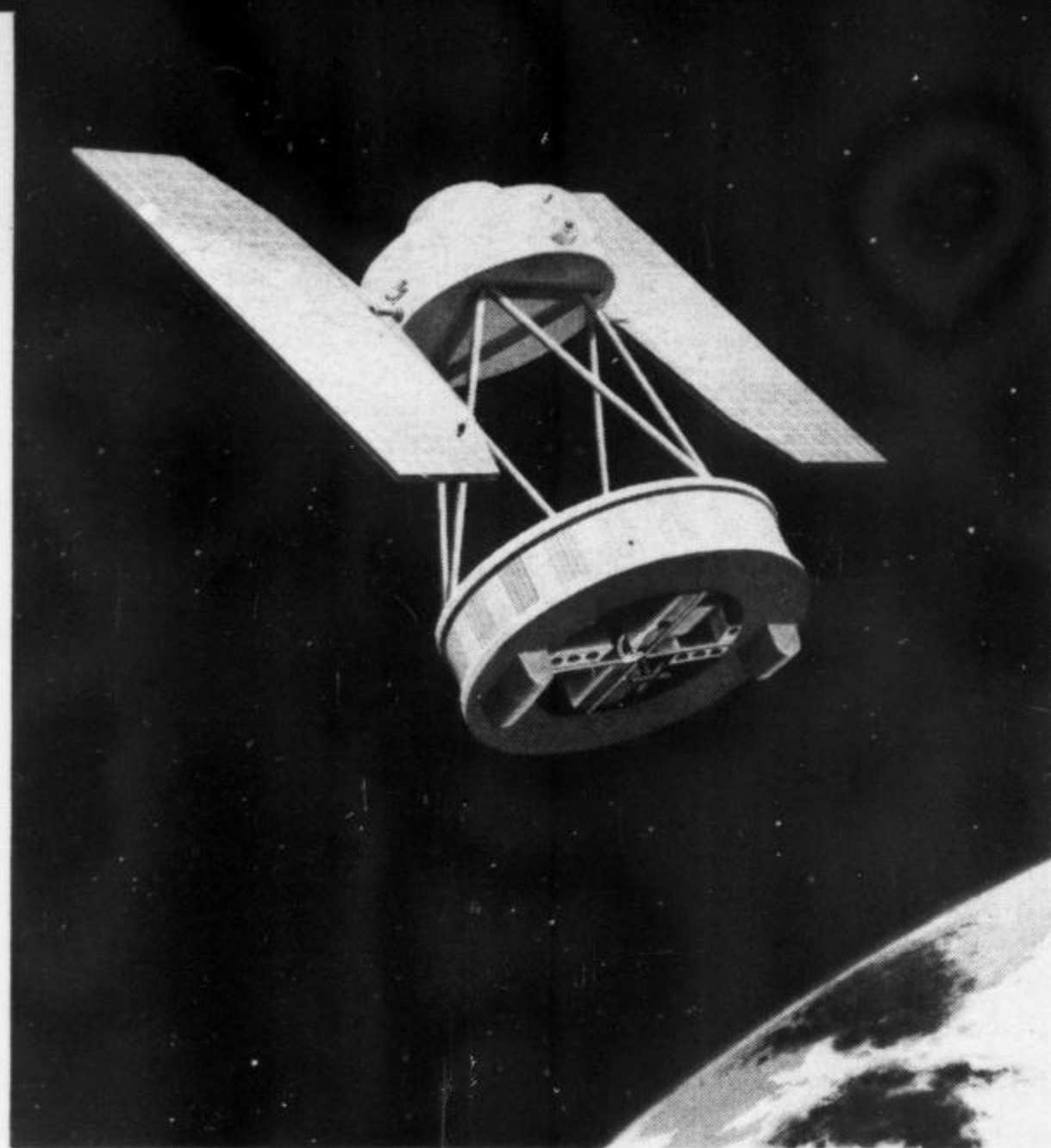
ing design parameters: for a payload of 100 tons, the craft itself would weigh 36 tons. An electric power of 6 megawatts would take the vehicle to the moon in 52 days, and back in about 8 days.

Probably the most challenging mission for an ion system will come when a manned flight to Mars or Venus is proposed. A Mars ship would first spiral around the earth until it obtained escape velocity of 7 mps. From then on, it would follow an out-bound powered spiral around the sun until it covered about half the distance between the orbits of the earth and Mars. Thrust would then be reversed and the vehicle would spiral towards Mars. A few thrust maneuvers to adjust velocity properly would lead to the vehicle's capture by the Martian gravity field. Finally, a close spiral around the planet would bring the spaceship into the desired Martian satellite orbit.

A manned expedition to Mars would probably be made with several vehicles of varied cargo capacity travelling together. Some would carry landing craft for flying to and fro from the Martian surface. Others would be packed with instruments, equipment and fuel for the exploration of the planet. The crew would be in one or several separate ships equipped with life-support systems. Assuming that each vehicle carries a payload of 150 tons, the total initial mass of each would be 435 tons, and the trip from earth to Mars would take about 300 days. The return trip would take 260 days, assuming that 150 tons of payload again is carried, consisting mostly of samples collected on the planet.

It is encouraging to note that the ion ship's travel time to Mars would not be much longer than the 260 days required by a chemically propelled ship. Forty more days for the ion ship should not be significant. The travellers selected for the trip to Mars will certainly

(continued on page 60)



SPACE ARTIST AT WORK

Roy Scarfo visualizes complex ideas. This is how he does it

by JOHN RUBLOWSKY

Exactly how does a space artist go about his work? Are these admirably realized details of a projected space vehicle merely a function of the artist's imagination, or are they determined by unalterable engineering principles?

To find out, we recently visited Roy Scarfo, art director of General Electric's Missile and Space Vehicle Department in Philadelphia.

We arrived one sunny morning at a rather prosaic downtown office building where an elevator whisked us up to the fourth floor. After the customary security precautions were accomplished, a secretary guided us to the art department where we met Roy Scarfo, with a bundle of rough drawings in his hand, on his way out.

"You're just in time," he remarked "I'm on my way to a consultation with one of the engineers. Come along, you'll see how a visualization is made. Terrific stuff here," he gestured with the roll of papers in his hand, "a really exciting concept."

Intrigued, we followed him through a maze of corridors, and up a few more flights on the elevator. We stopped at the neat, unostentatious office of Dandridge Cole, advanced systems planning specialist. Roy spread



Consultation. Artist Scarfo, right, goes over details of drawing with Dandridge Cole, advanced systems engineer.

the drawings on the desk and Cole proceeded to a critical examination of the roughs.

Roy, meanwhile, explained the procedure: "All the preliminary work is done with these rough drawings. We go over the details with engineers and don't start on the final version until they're satisfied that everything is in accord with scientific and engineering fact. This way, we're not apt to make a big blunder on the finished art."

Actually, this was the second step in the process. "The first thing we do," Roy continued, "before we start work on the roughs, is talk with the engineers. They explain what they want, and together, we go over each element in the concept, study blueprints or engineering 3-D drawings—if they have them—and get a pretty general idea of where we're going."

At this point, Dandridge Cole, who had been poring over the drawings, interrupted. "This won't do," he said, picking up a drawing of a hollowed asteroid that housed a macro-life colony. "The wheels on the tractor are wrong. They'd work fine in earth's gravity, but remember, there'll be only a fraction of that figure on the asteroid."

He took a pencil and drew a crude sketch of a big-balloon type tire that would be more in keeping with the asteroid environment. "Try to get in something like this," he said.

There were a few more things that needed fixing: a Mars landing-probe has the wrong aerodynamic configuration; earth's perspective would be different when seen from a satellite orbiting at 23,000 miles; a lunar explorer was wearing an unsuitable type of pressure suit.

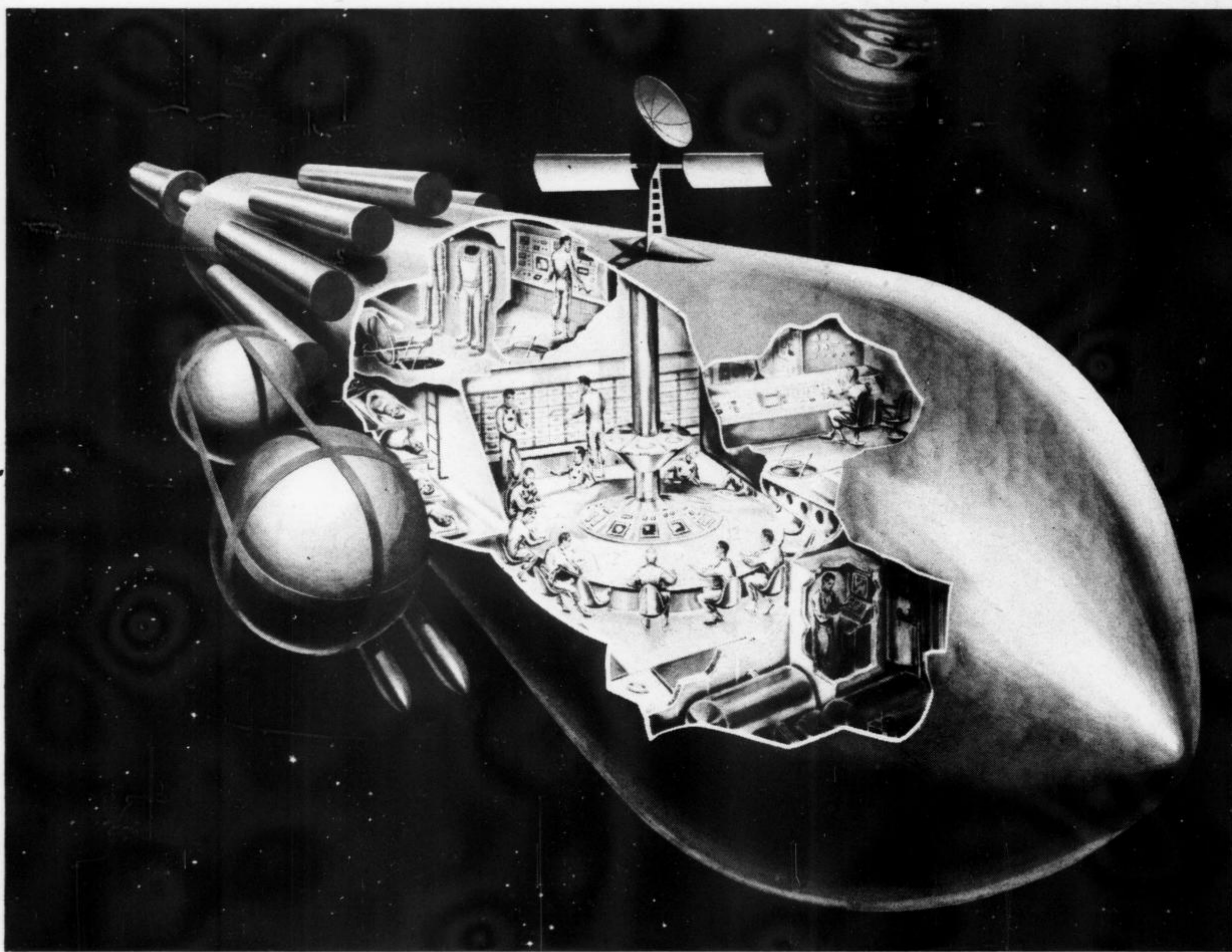
Roy noted all the comments in a small pad, and made tentative changes on the drawings. Consultation finished, we headed back to the art department.

"Should have realized about those wheels," Roy chided himself as we walked. "They were earth wheels and you couldn't expect *them* to work on an asteroid. You know," he added, an infectious grin spreading over his face, "you can really get caught up in this kind of thing."

At lunch, Roy spoke knowingly about such technical matters as aerodynamic configuration, solar cell arrangement, optimum drag design, etc., and we wondered whether he had had a technical education.

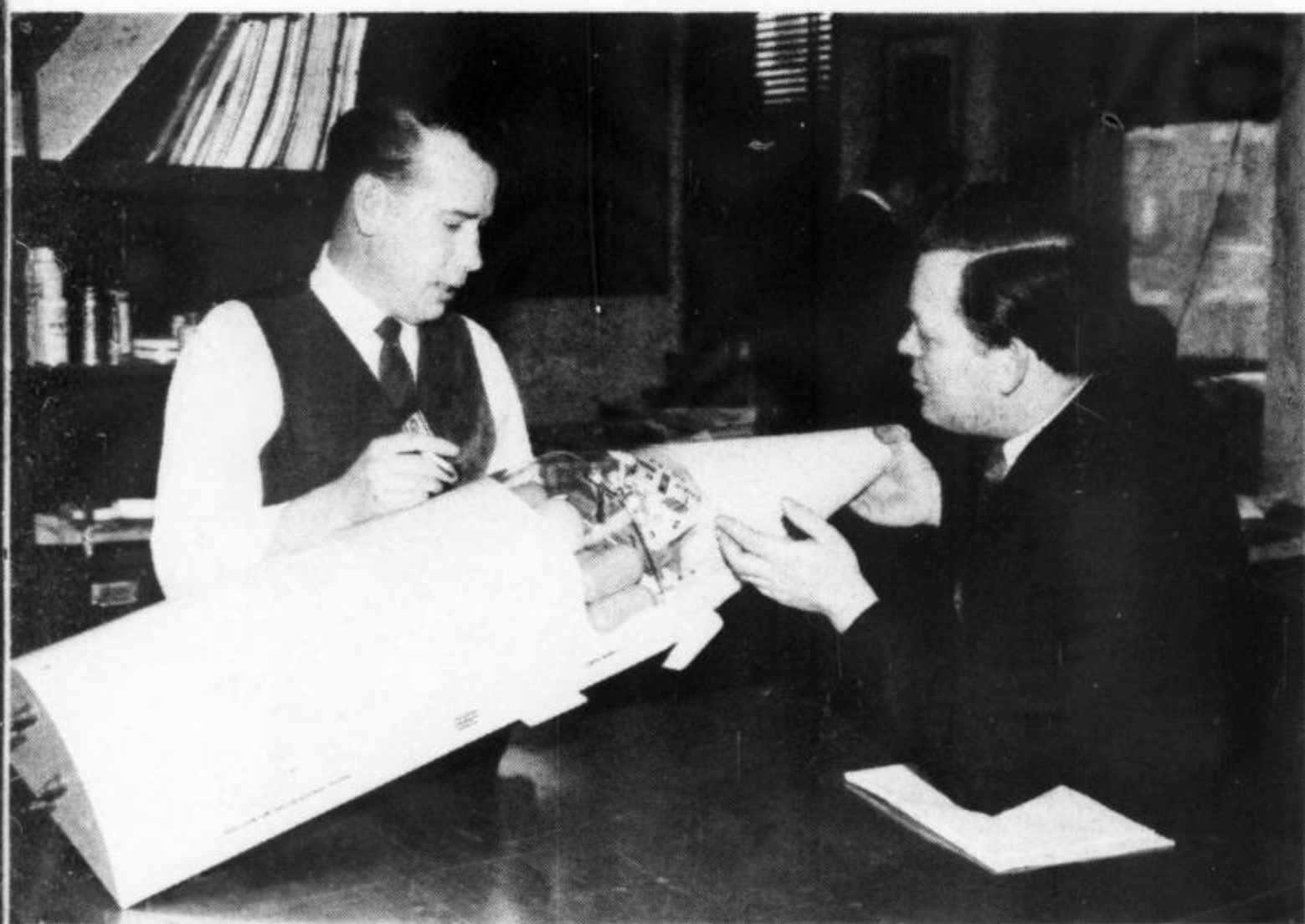
"Not in school," Roy smiled. "I studied art, but I'm

(continued on next page)



Interplanetary Vehicle. This visualization was executed from rough engineering drawings and blueprints.

The artist must combine accuracy and imagination



Slo-Mar Model. The author, right, examines model of two-man re-entry vehicle designed by Scarfo and art department staff.

getting my technical education right here. I've been with GE for four years, executing visualizations with some of the top space technologists in the country. In that time something had to rub off."

Roy hails from Pittsburgh where he studied at the Art Institute. He came to Philadelphia when he was called into the service for the second time, during the Korean War. He worked in the Marine Corps Information Office in this city. After his discharge, Roy decided that he liked Philadelphia so he joined the GE Missile and Space Vehicle Department here and settled down.

He now lives in a house in Levittown, a development in the Philadelphia suburbs, with his wife and two daughters.

When we returned to the office, Roy showed us a model of a Slo-Mar two-man re-entry vehicle. It was exquisitely made, with a clear lucite inset that showed the interior cabin arrangement in exhaustive detail.



Lunar Probe. Accuracy of detail in this kind of visualization is achieved by working closely with engineers and designers.

"The shape," Roy said, "is determined by aerodynamic principles, allowing for maximum drag and minimum re-entry heating. This is another part of our job. We design models, like this one, and supervise their construction."

As we were admiring the model, we were interrupted by Joseph C. Hoffman, manager of Production Information for the division, who came in with another engineer.

Hoffman said, "They've changed the appointment date for that presentation."

"We have to be in Washington Friday afternoon," the engineer added. "And we must have the presentation."

Roy started figuring. "267 color slides, 27 charts, 110 visualizations," he muttered. "If you need it by Friday, you'll have to get it by Friday."

The preparation of these customer presentations, we learned later, represents the bulk of the art department's work. In the course of a year the staff prepares upwards of 200 of them. Roy and his staff, working closely with

the engineers, must prepare an exhibit that visually explains the feasibility work of the engineers and scientists. Without this kind of aid, the engineers find it almost impossible to adequately describe and explain their proposals.

This particular presentation was for an advanced space vehicle design that was being considered by NASA. Roy was unable to tell us exactly what it was because of security precautions, but he did say that it was an extremely important project that the GE engineering staff had been studying for months.

Now, all this work had to be condensed into an 8-hour presentation on which an important contract hinged. As the manager, Joseph Hoffman, Roy and the engineer discussed the problem, our idea of the importance of the art department's task was confirmed. As we left, we heard Roy speaking on the telephone:

"No," he said, "don't wait supper for me, I don't know what time I'll be home." ■ ■

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GEN. MEDARIS: Right or wrong?

'FLYING SAUCER' PHENOMENA

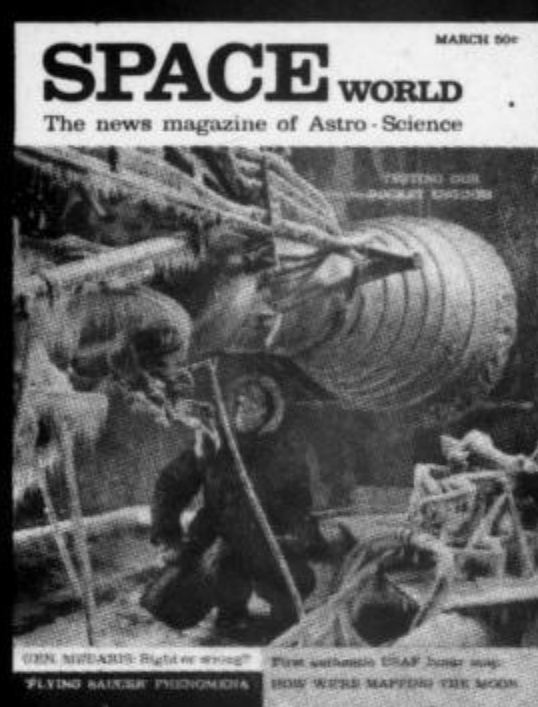
First authentic USAF lunar map

HOW WE MAPPING THE MOON

MARCH 1961
VOL. 1 — No. 6

SPACE WORLD

ABOUT THE COVER



Cover shows technician at the Canoga Park plant of Rocketdyne inspecting a Thor IRBM engine during a low-temperature test in a walk-in environmental chamber. For a full report on rocket engine tests see article starting page 24.

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CONTENTS

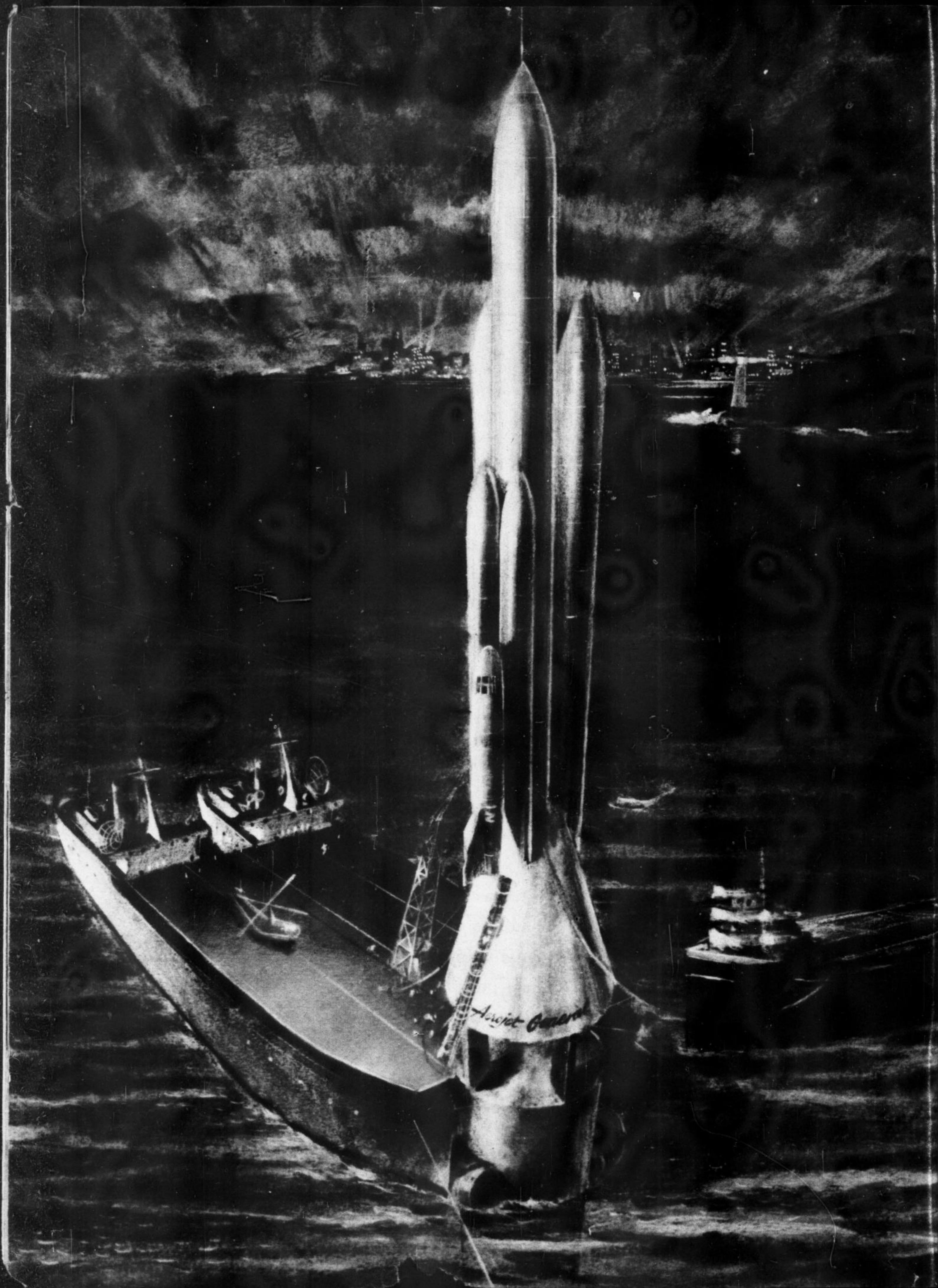
ARTICLES

- 10 CAN WE DO BUSINESS IN SPACE?**
A symposium in which several leading authorities offer their answers.
- 14 MAPPING THE MOON, by Charles F. Campen, Jr.**
An exclusive story by the director of USAF's Lunar mapping program.
- 20 TOUGH-TALKING GENERAL, by John Rublowsky**
Gen. John B. Medaris pulls no punches in this controversial article.
- 24 ENGINE RELIABILITY, by Edward A. Herron**
A report on some of the exhaustive tests given to our rocket engines.
- 28 THE WORLD OF 1971, by Ernest Haussman**
Space-age technology will affect all areas of life in the next decade.
- 32 SPACE PROSPECTORS, by Willy Ley**
A look at some of the treasures that may be brought back from space.
- 34 THINKING BIG—IN A SMALL WAY, by Horace Gilbert**
The problems of miniaturization, by a recognized leader in this field.
- 40 'FLYING SAUCER' PHENOMENA, by Otto O. Binder**
This factual report reveals what we know—and don't know—about UFOs.

DEPARTMENTS

- 4 LETTERS TO THE EDITOR**
- 6 ORBITING AROUND**
- 22 WHAT'S NEW**
- 38 BOOK REVIEWS**
- 43 NAMES IN THE NEWS**
- 45 SPACE QUIZ**

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CAN WE DO BUSINESS IN SPACE?

Yes, say the three experts who contribute to this symposium

Can space commerce costs be made low enough so that shipments of exotic cargo from other worlds will become competitive in the earthly market?

At the present time the answer seems to be no. The cost of sending payloads into orbit, a mere 300 miles up, is anywhere from \$500 to \$5,000 a pound — which would seem to preclude any possibility of practical space commerce. But before you accept this pessimistic answer, remember that three years ago that cost was from \$10,000 to \$100,000 per pound.

Thus, we have seen a marked reduction in space costs in a short time. Will the process continue?

Today, the major aerospace firms emphatically say YES! Many of them foresee "private space enterprise" making its debut within the next decade.

However, most executives of aerospace firms say that business cannot absorb the entire cost at the start. Government subsidy must still underwrite the expensive booster and launch facilities. From there on private industry can take over, meeting the cost of the vehicles and payloads required.

How will the phase of "free interplanetary enterprise" be launched? Three experts of the aerospace industry have prepared the answers for SPACE WORLD:

by R. C. TRUAX, Capt. U.S.N. (Ret.)

Director, Advanced Development Liquid Rocket Plant, Aerojet-General Corporation

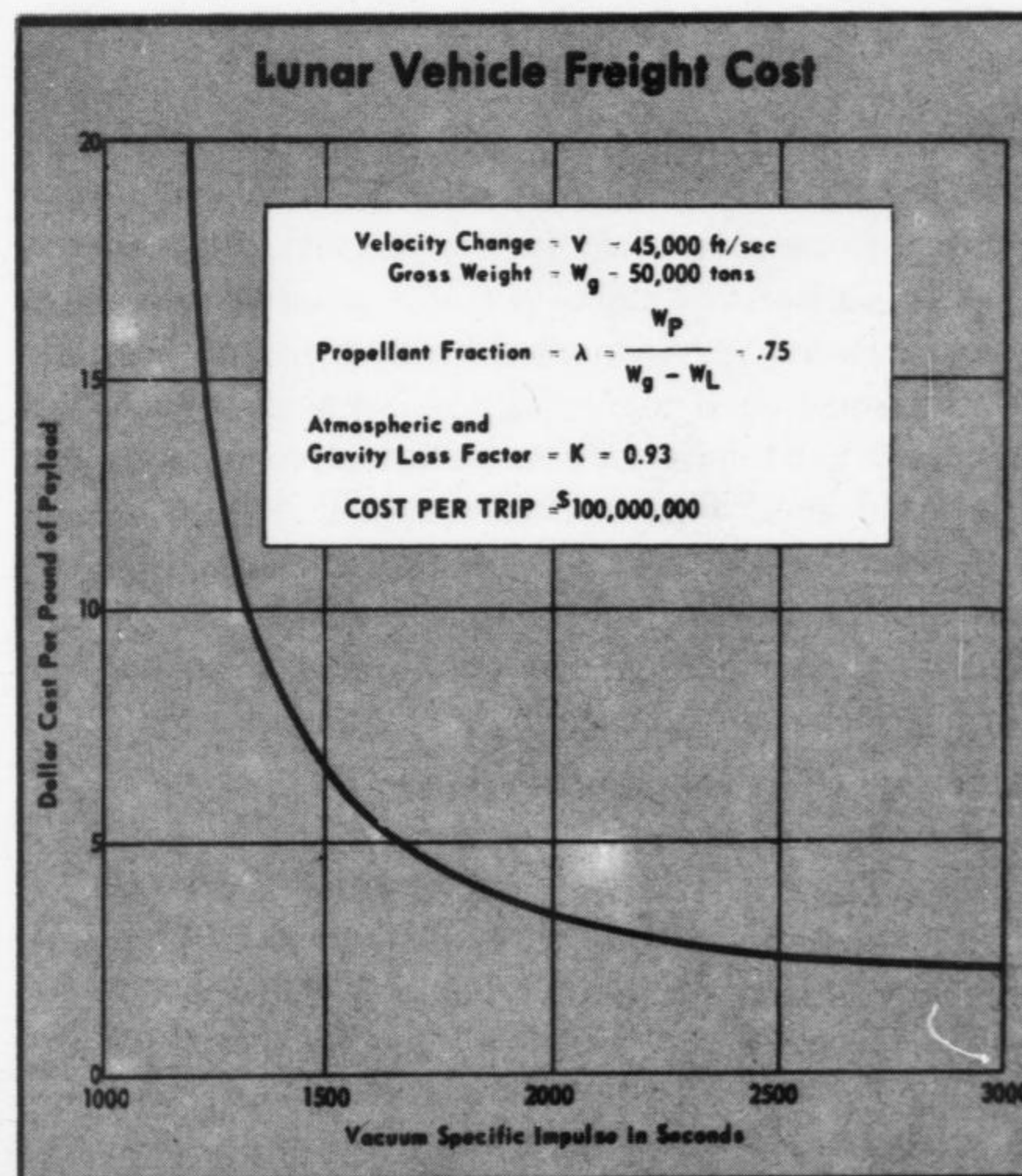
Compared with prior forms of locomotion, a space rocket is a huge, highly-engineered vehicle which carries a miniscule payload. Moreover, these enormous machines make one roaring flight of only minutes duration and then crash as a mass of twisted or molten wreckage.

Cost data are presently available only for Project Van-

guard. Here a vehicle costing in the neighborhood of two million dollars was used to put about 20 pounds into orbit. The cost of transportation, based on vehicle cost alone, is \$100,000 per pound. The total program succeeded in putting about 125 pounds in orbit at a cost of \$125,000,000 — or a million dollars per pound. Certainly, on a large scale, such operations could exceed in cost the entire gross national product, and on this basis the idea of commercial spaceships plying between the solar bodies is farfetched indeed.

But the time is not far past when we were scratching our heads and our pencils very hard to show that *any* payload at any cost could be placed into orbit around the earth. This most elementary of all space missions, only a few years ago, seemed to be on the borderline of practical attainability.

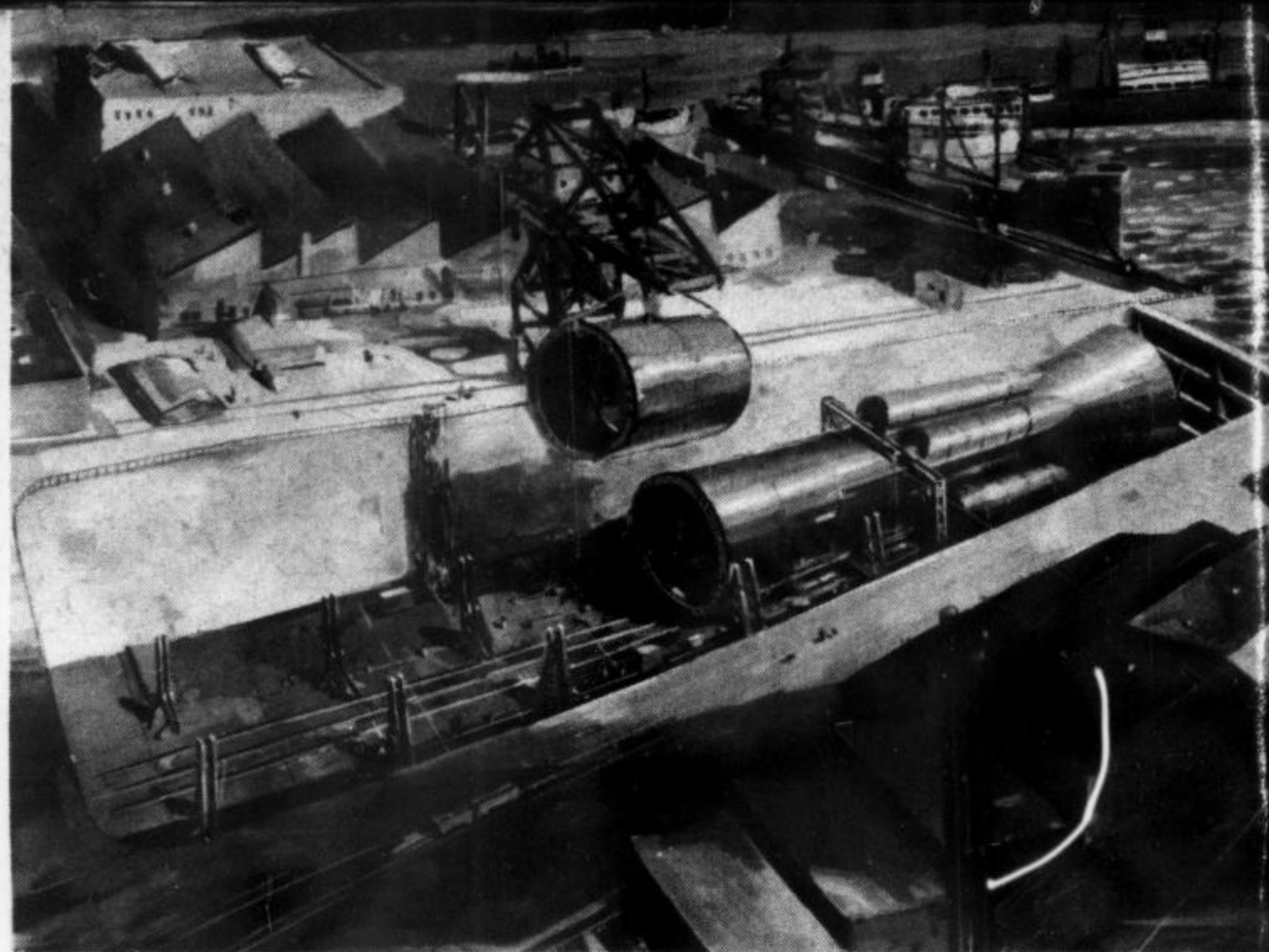
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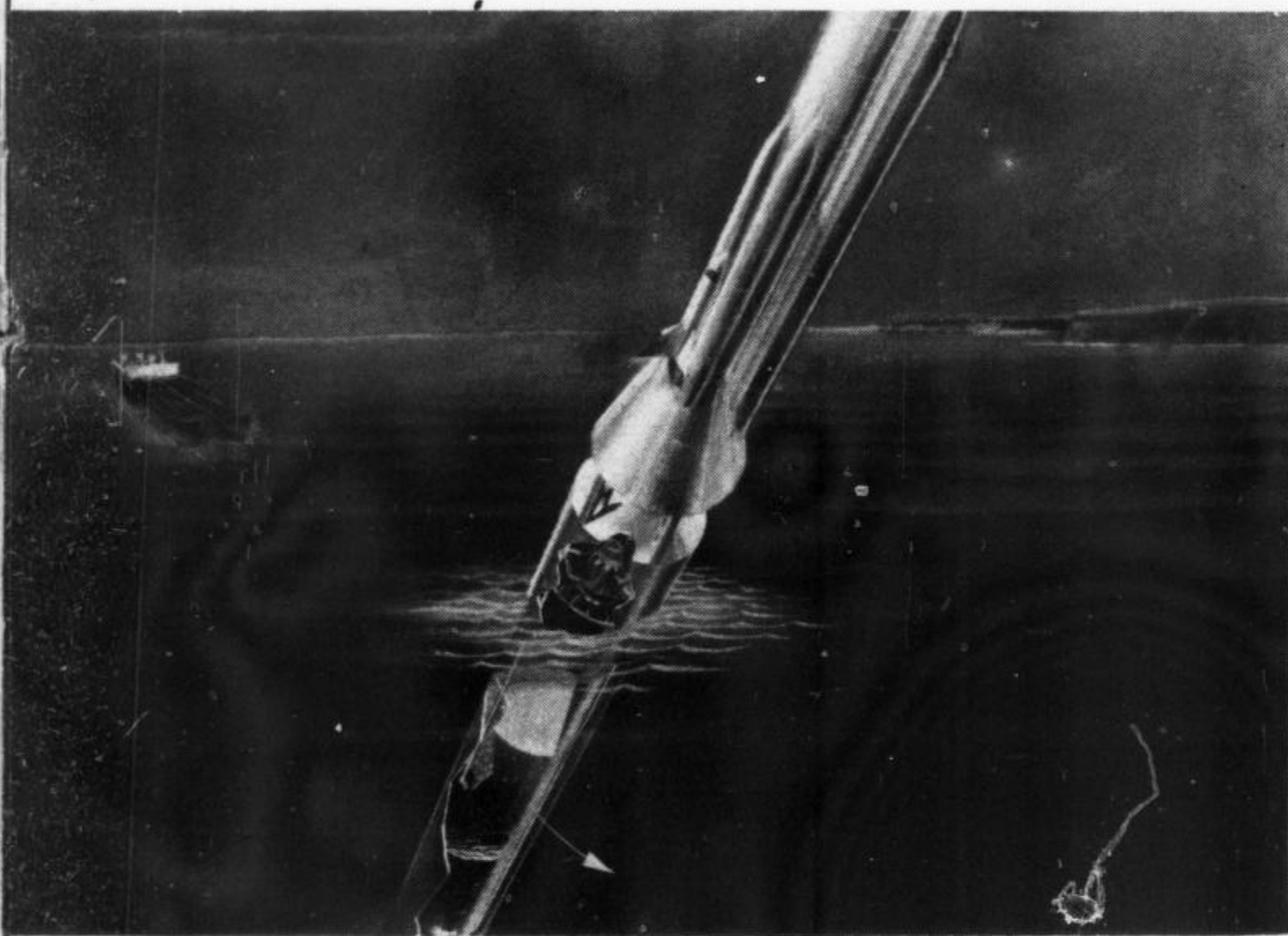
COMMERCIAL SPACE LINER. At left is artist's conception of a giant rocket that could be used for space commerce. Graph at right shows payload transport costs in relation to engine thrust.

BUSINESS IN SPACE? *continued*

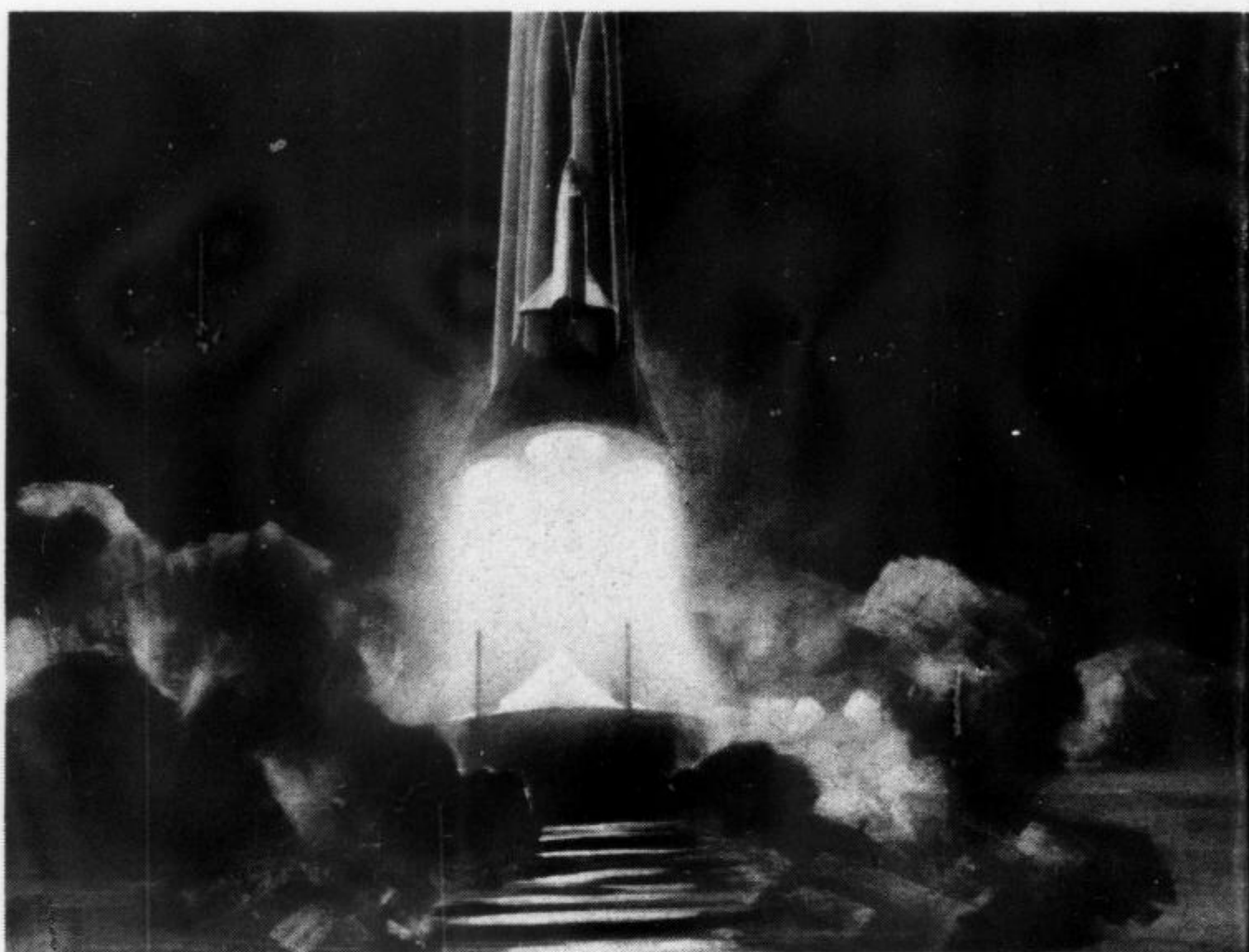
Pictures on this page show operation and launching of a giant commercial booster



1 Rocketliner airframe is assembled in huge drydock.



4 Inexpensive launching facility is provided by sea.



5 Cluster of 6 engines generates 6,000,000-lbs. thrust.

How close we were to the edge of the impossible was demonstrated by Vanguard I, when a three-pound satellite had to be substituted for the original 20-pounder to save 17 pounds of weight. Out of a gross takeoff weight of more than 20,000 pounds, 17 pounds meant the difference between success and failure. Yet now, without any major advances in technique, multi-ton payloads are easily placed into orbit.

The primary reason for the improvement, and the reason which leads one to be optimistic about the future, is that we continuously find means for improving the performance of our equipment on a *cost* basis, as well as on an *engineering* basis.

Growth of Useful Load

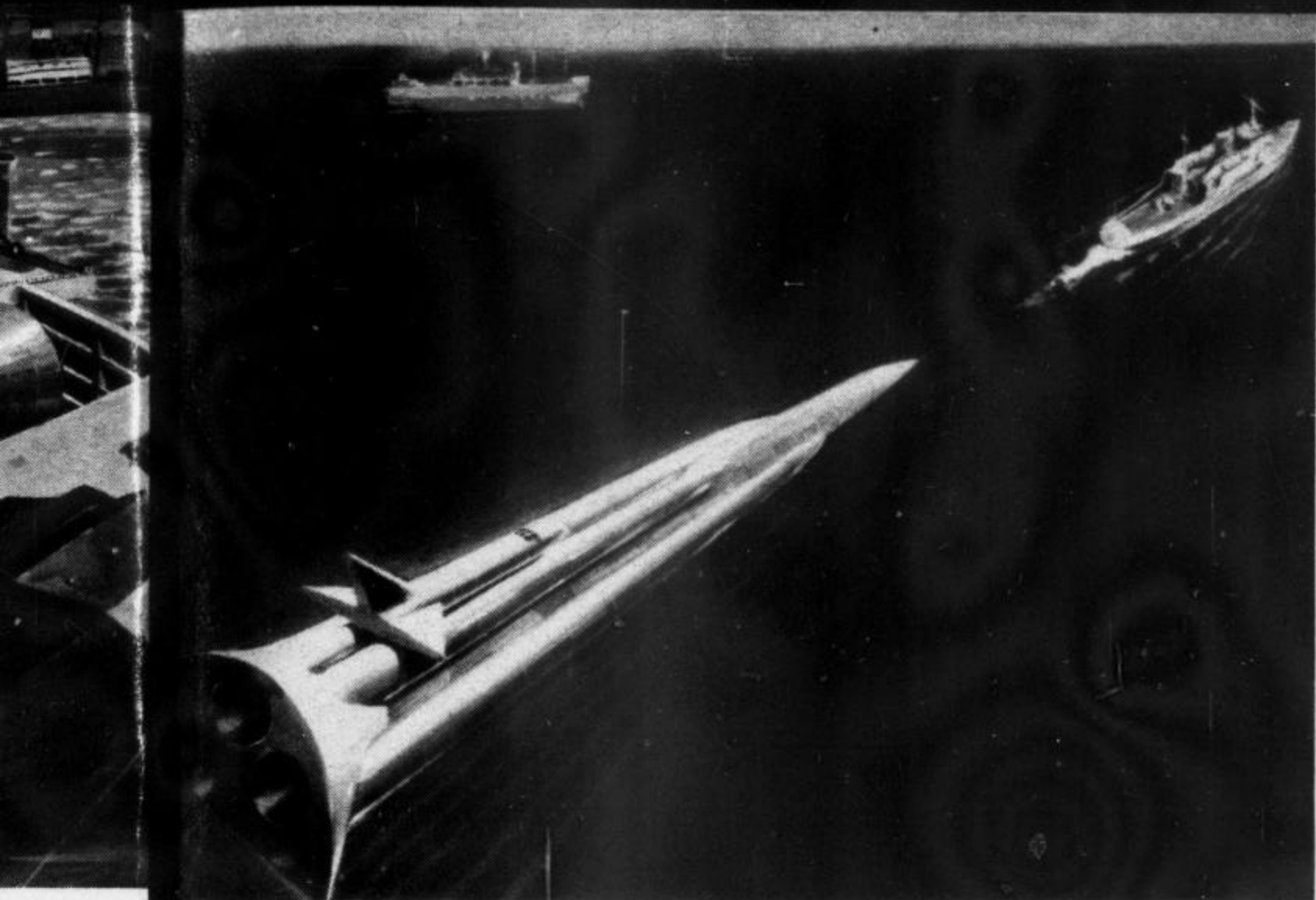
Over the past 10 years, the improvement in items critical to the performance of a rocket, such as propellant consumption and structural weight, has not been decisive. The principal change has been an increase in size, and a reduction in unit cost because of an expanding utility

which permits one-time costs to be spread over a large number of units.

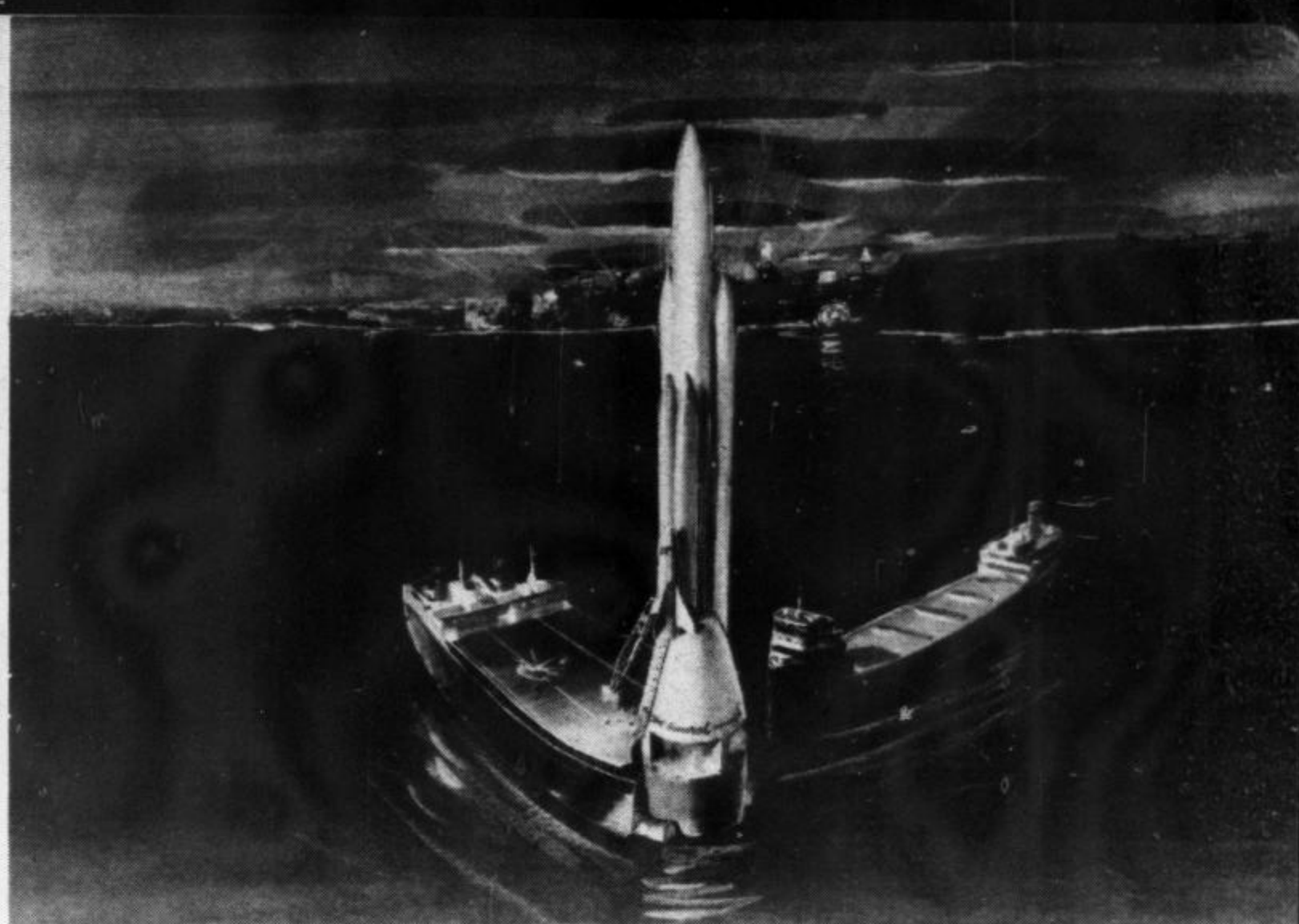
An increase in missile size has two important effects. The first is that the proportion of useful load which may be carried increases. This increase results from the fact that many of the items of equipment which must be carried for a vehicle to fulfill its mission are of fixed size and weight, regardless of the size of the vehicle to which they are attached. The guidance equipment is a notable example. In addition, there are certain practical limits to the thicknesses of the metal which may be used, imposed by limitations in fabricating techniques. As a result, large structures can generally be made somewhat more efficient.

In addition to the engineering advantages in large size, there is cost advantage as well. In general, for a given degree of complexity, it costs no more to design a large structure than it does to design a small one. Nor does it usually require a proportionate increase in testing costs.

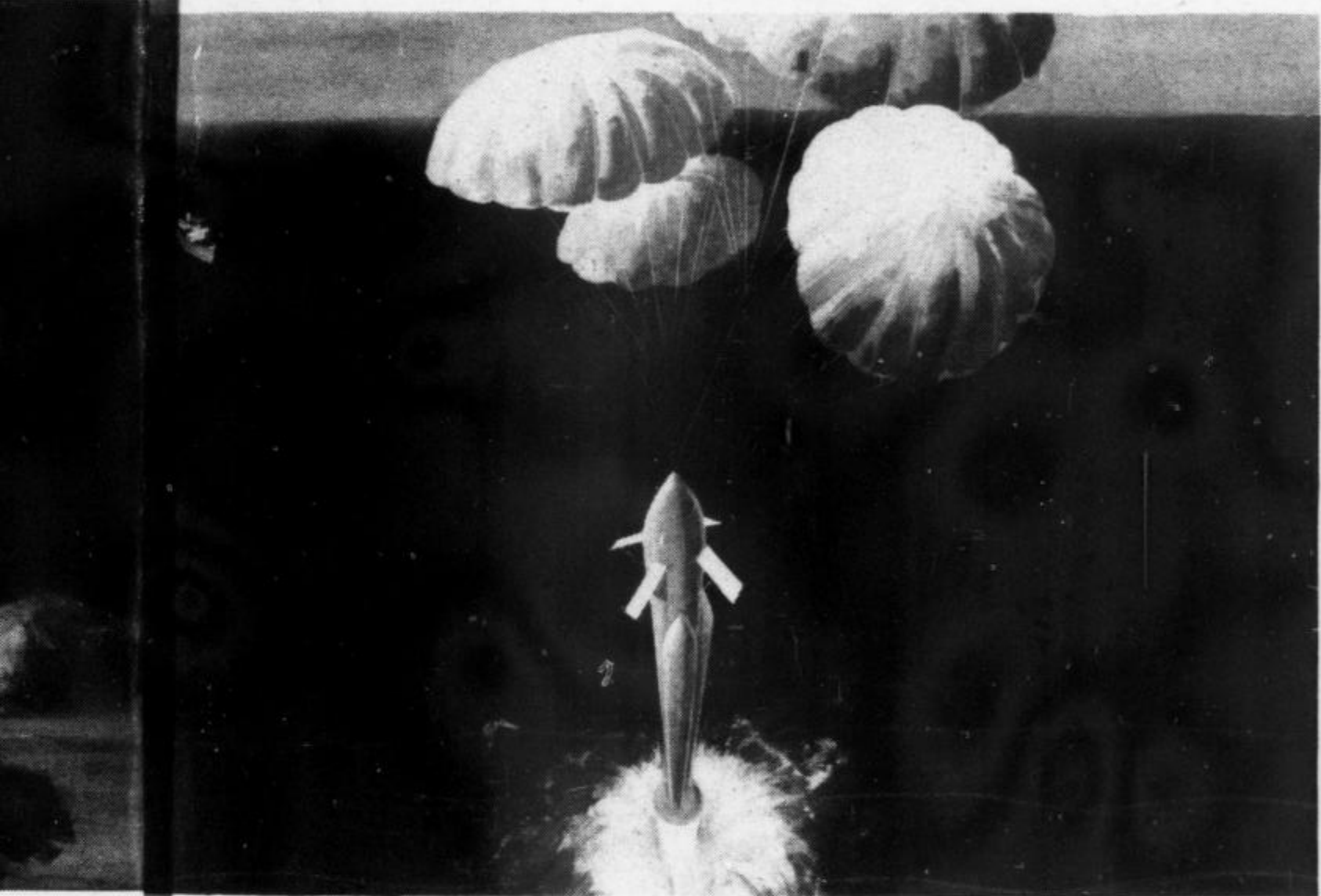
After a vehicle is launched, many of the functions do not vary at all with size. These functions consist primarily of tracking and communications. Certainly it requires



2 Assembled liner is towed by tug to launching site.



3 Rocket is launched at sea far from shipping lanes.



6 Spent booster lowered back to sea by drag-chutes.



7 Floating drydock retrieves booster for later re-use.

no more expensive an operation to track a large missile than it does to track a small one. In fact, cheaper and simpler equipment may sometimes be used for the large missile.

The simple increase in rocket size, then, with its corresponding expansion of utility, is one of the principal means of cost reduction in space transportation.

In attempting to find additional means for reducing costs, one cannot fail to note that in no other mode of transportation does one even contemplate expenditure of the vehicle after only one trip. Such a procedure for aircraft, train, automobile or ship transportation systems would impose an economic penalty that would completely erase their economic utility.

The economic utilization of space transportation has been seriously hampered by its historical relationship to the military-oriented guided missile. In such use, the vehicle is either automatically destroyed at the end of the flight, or is used under such circumstances as to render recovery of the vehicle extremely difficult. Nevertheless, if we examine the technical problems of providing

multiple-use capability, the difficulties do not seem insurmountable.

A rocket vehicle designed to be re-usable may differ markedly from an expendable one, or the difference may be in detail only. Such a re-usable booster would necessarily place heavy emphasis on simplicity and reliability, at the expense of performance, if necessary, since it appears probable that the total number of re-uses obtainable would be a direct function of the reliability. It also seems likely that the reconditioning and checkout cost would vary in proportion to complexity.

Propellant Costs Low

But even granting the development of very large recoverable vehicles, it may still be difficult to visualize space operations being routinely conducted on a large tonnage basis. The rocket vehicle appears to be such an enormous thing for the amount of payload carried. It should be noted, however, that 80 to 90 per cent of the total mass of the rocket is propellant which, at least in

(continued on page 42)

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MAPPING THE MOON

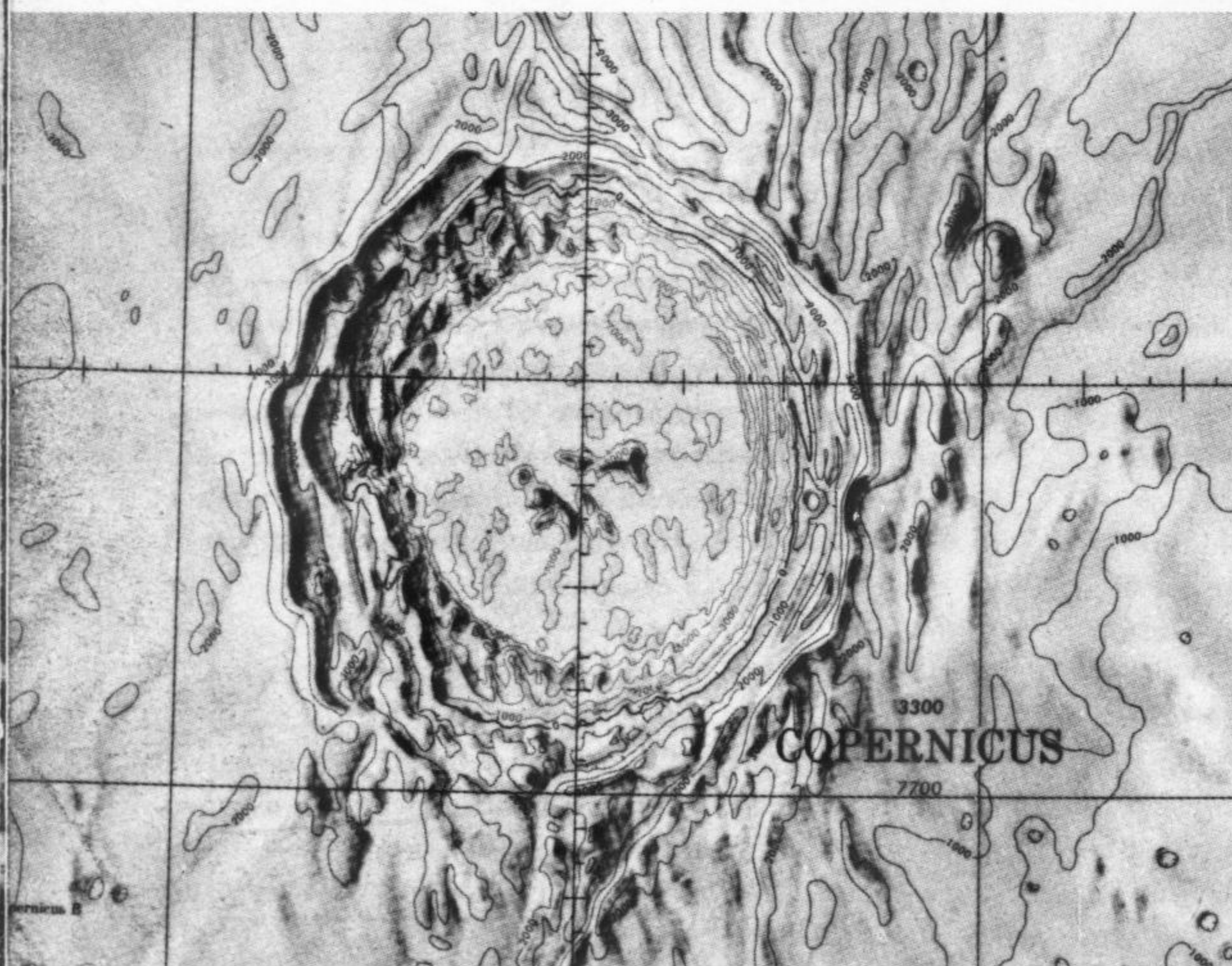
The project director gives us an exclusive report on the USAF Lunar charting program

by CHARLES F. CAMPEN, Jr.

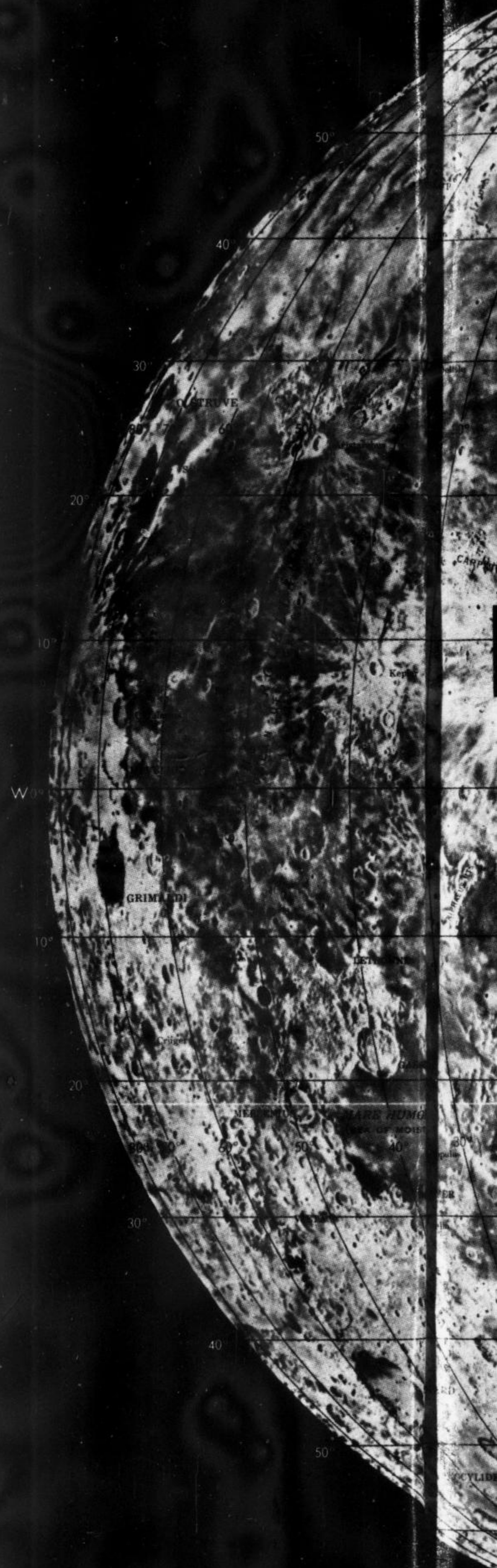
On a clear night, an observer on earth can make out the major topographical features of the full moon with his naked eye. He can see the huge dark patches of the maria (seas) that contrast with the icy whiteness of the surrounding areas.

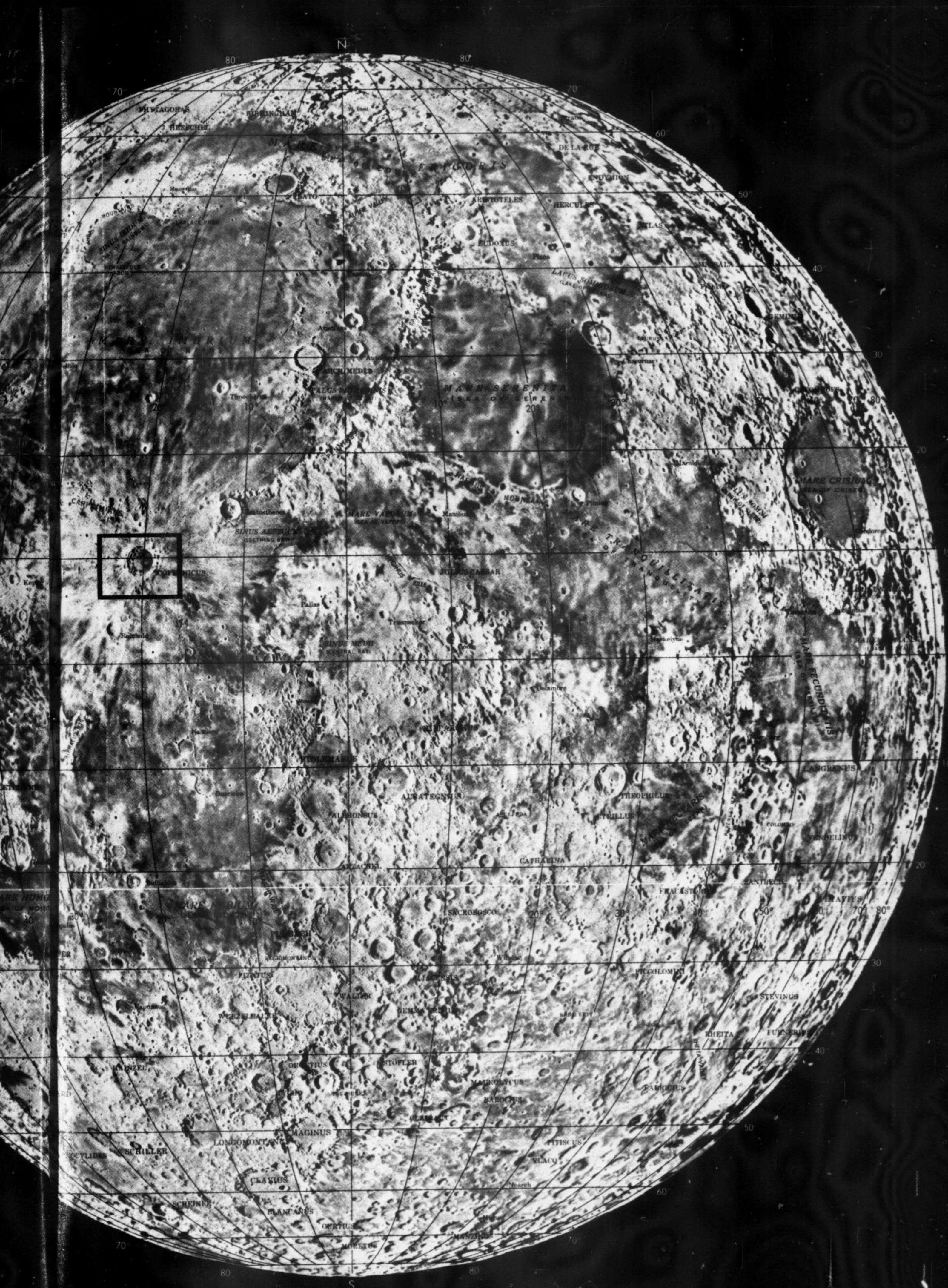
When atmospheric conditions are particularly favorable, he can, if he looks long and carefully, see the crater Copernicus just to the left and slightly above the center of the full moon. It stands out, white and icy, between the dark areas of the Mare Imbrium (Sea of Rains) above, and the Mare Nubium (Sea of Clouds) below.

(continued on page 16)



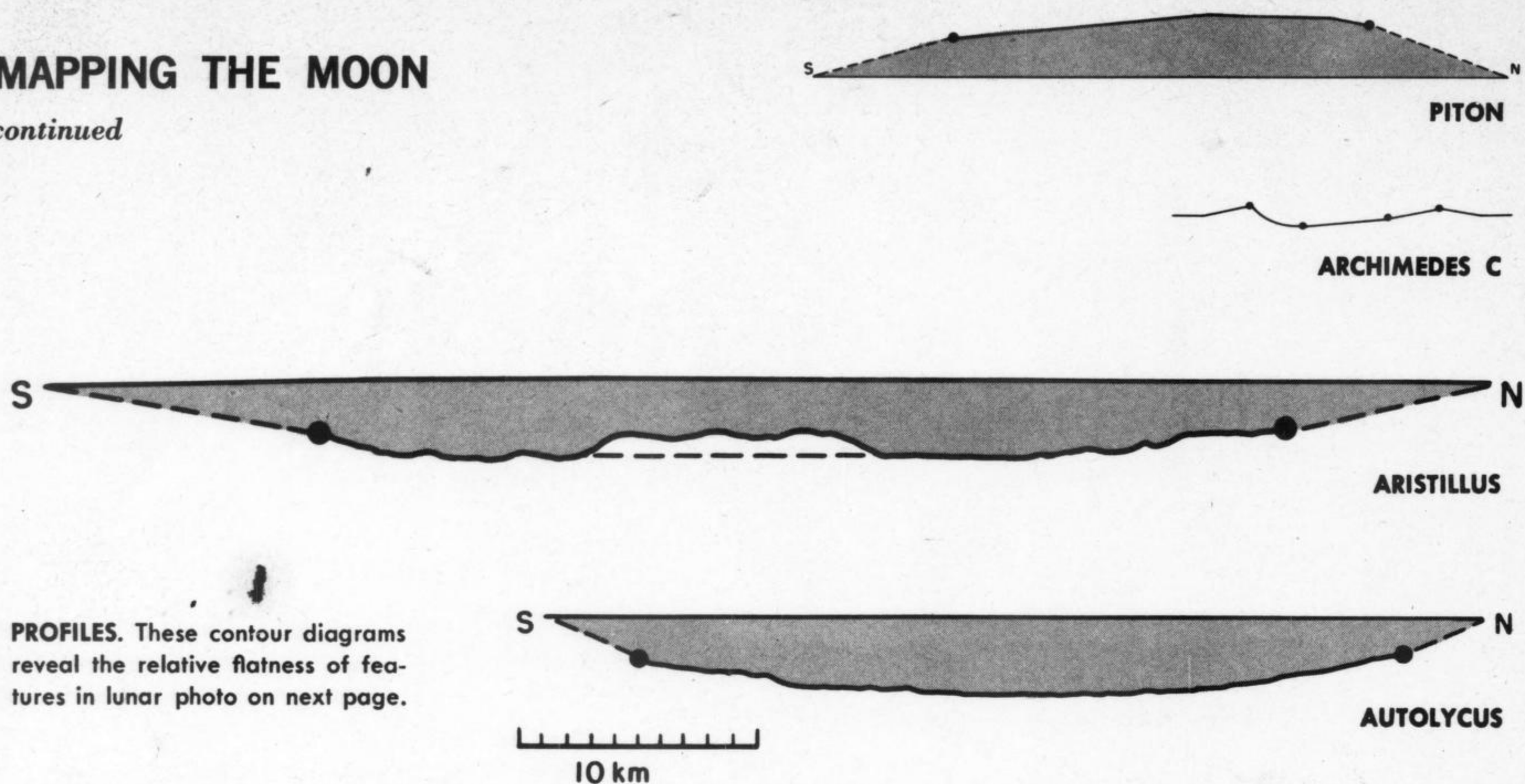
CRATER COPERNICUS. Contour map (above), first of its kind ever released, shows details of lunar surface. Area is boxed on lunar reference chart (right).





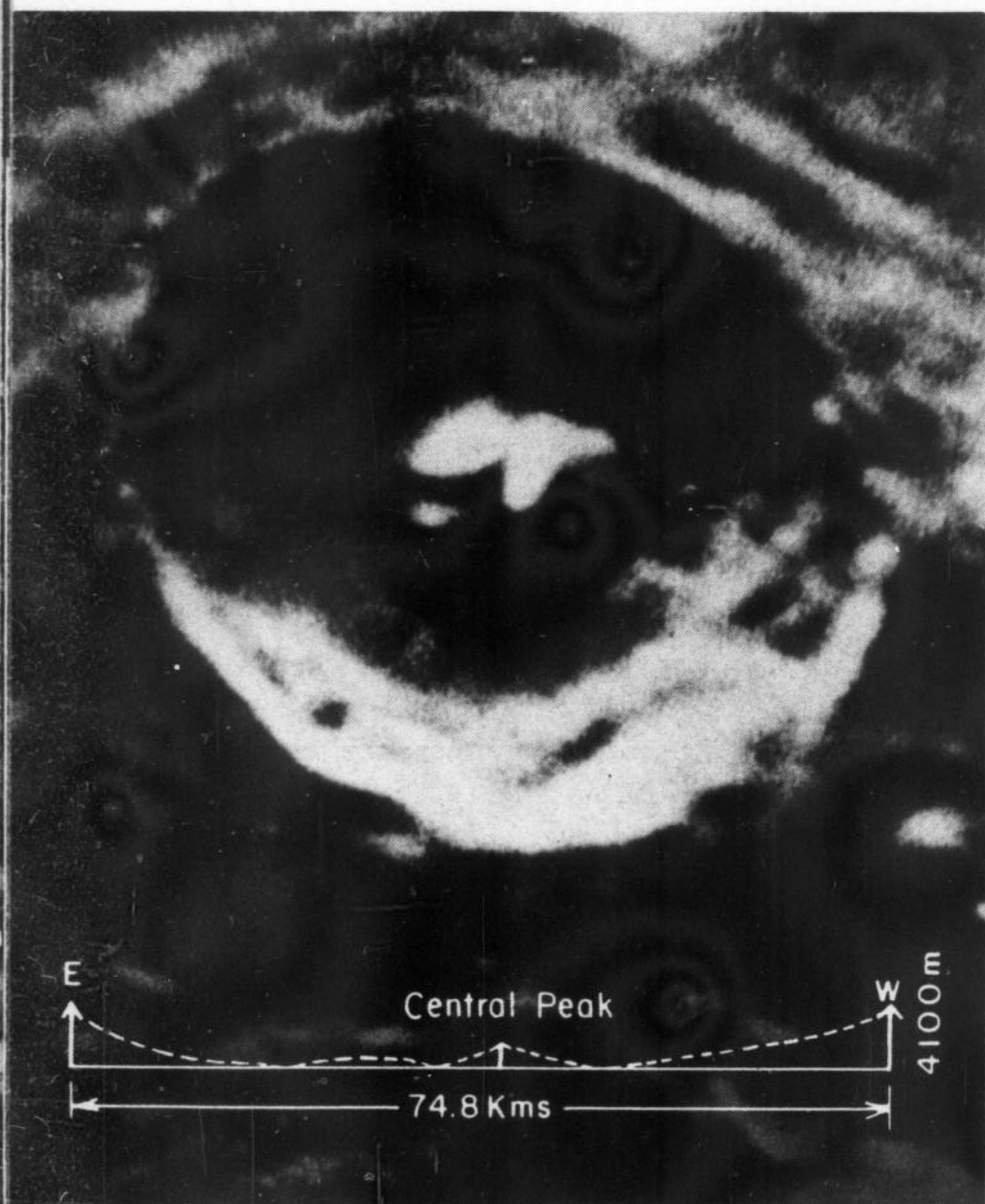
MAPPING THE MOON

continued



PROFILES. These contour diagrams reveal the relative flatness of features in lunar photo on next page.

Probability of manned landing made lunar maps a necessity



Though he can make out a few large features on the face of the moon, the overall impression registered on his unaided eye is that of a flat disc with clearly defined areas of brightness and darkness.

Through a telescope, however, the entire visage changes. Now, the observer sees a rough, angular terrain with jagged peaks that cast grotesque shadows behind them. The contrasting areas become more sharply defined and even with a small telescope, he can readily identify the various mountain ranges, craters and maria on the surface of the moon.

The crater Copernicus, when seen through the telescope, looms monstrosly large, with apparently sheer walls rising abruptly from the maria plain to tower high above. Within the rim of the crater, high jagged peaks rise precipitously from the crater floor. When seen through the telescope during the time of full moon, rays fan out from the center of Copernicus over the lunar landscape like the spokes of a giant wheel.

Today, as a result of an extensive moon mapping project under my direction by the Lunar-Planetary Exploration Branch of the Air Force's Geophysics Research Directorate, we have a pretty good idea of what an observer would see if he were transported to the moon.

Let us suppose that our observer stood just outside

THEOPHILUS. This prominent crater on western shore of the Sea of Nectar is a long, shallow depression on lunar surface.



PROFILE. Lunar features which appear steep when viewed through telescope are actually quite flat, as shown in profiles, left.

the crater Copernicus. What sort of topography would the moon present to him from this vantage point? What would he see?

On Copernicus' Rim

First of all, the rim of Copernicus would not be nearly as high as the telescopic view had led him to believe, nor would its rise be as sheer. Instead, the walls would slope upwards in a series of gentle rises, to a peak of some 5,000 feet. The terrain itself, however, might be extremely rugged because of possible existence of boulders or other surface irregularities not discernible with our telescopes.

Because of the smaller gravitation attraction of the moon, scaling of such heights would present no great obstacle—a less formidable challenge to our moon explorer than might have been anticipated before our new measurements of lunar topography were begun.

Once on top of the crater rim, our observer would see the walls slope gently down the other side. Within the crater itself, he would see a score of low hills with higher prominences towards the center of Copernicus. They will probably appear as rolling hills to our explorer. None of them will rise precipitously from the crater floor.

How can we be certain of a topographical profile that has been viewed and measured from a distance of some 239,000 miles? Because this description is based upon the findings of a study that has utilized the most advanced

and scientifically accurate techniques now available for measuring and mapping just such features on the face of the moon.

It is a result of a moon charting program undertaken by the Geophysics Research Directorate of the Cambridge Research Laboratories, Air Force Research Division at Hanscom Field, Bedford, Mass.

This program may be considered a partial fulfillment of the dreams of the earliest astronomers. In the year 1780, astronomer William Herschel, who did pioneer work on lunar geographical measurements, admitted wistfully that: "It may perhaps be esteemed to be a mere matter of curiosity to search after the height of the lunar mountains."

Whatever may have been the opinion prevalent in Herschel's time, the determination of the heights of lunar mountains is no longer a matter of mere curiosity. Looking toward the day when manned lunar landings are a reality, construction of adequate moon maps has become a vital necessity.

Preliminary Work

The task of derivation of new techniques and acquisition of basic data from which such maps could be made was undertaken by the Lunar-Planetary Exploration Branch at the Geophysics Research Directorate. To assist in this project, I enlisted the aid of lunar experts from

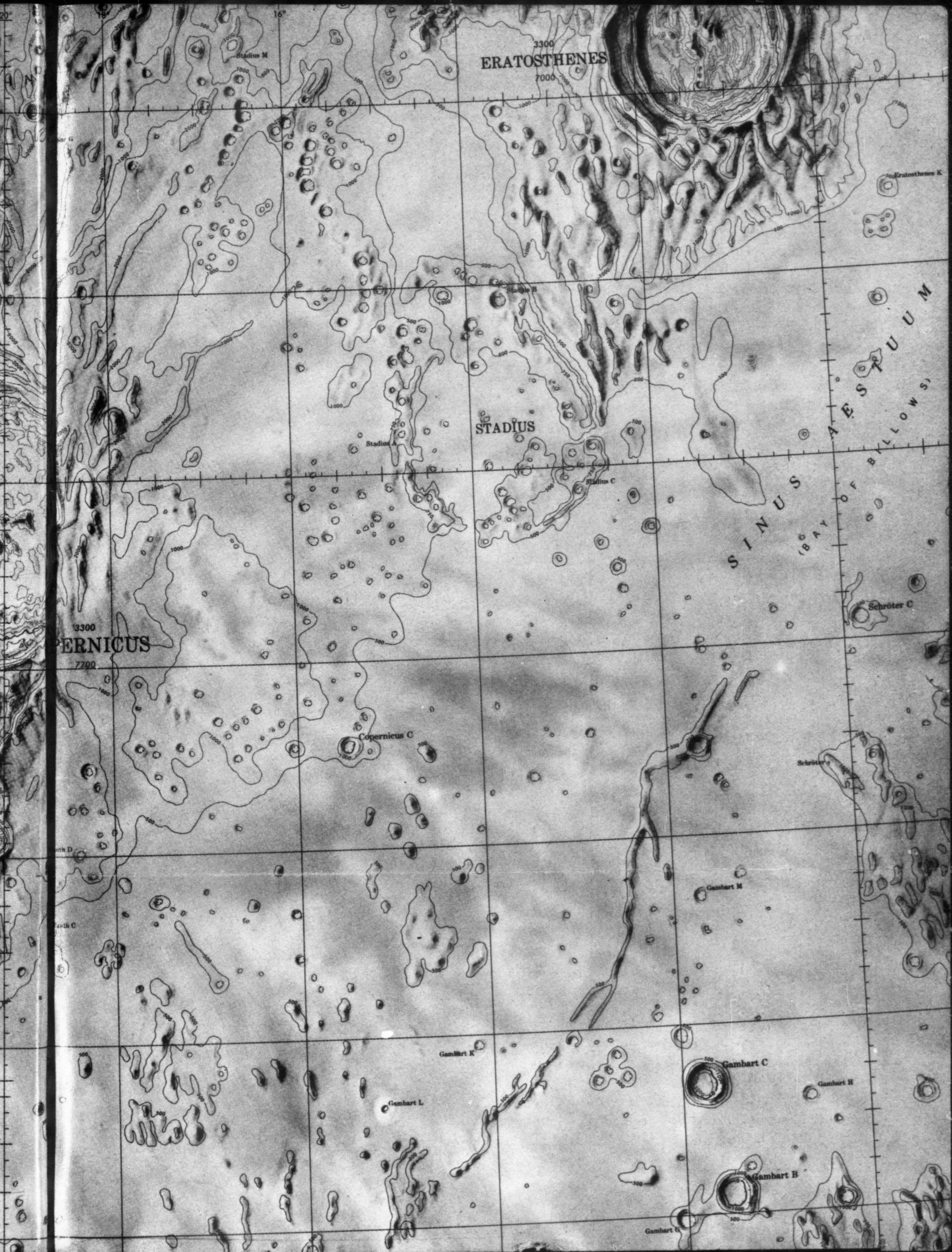
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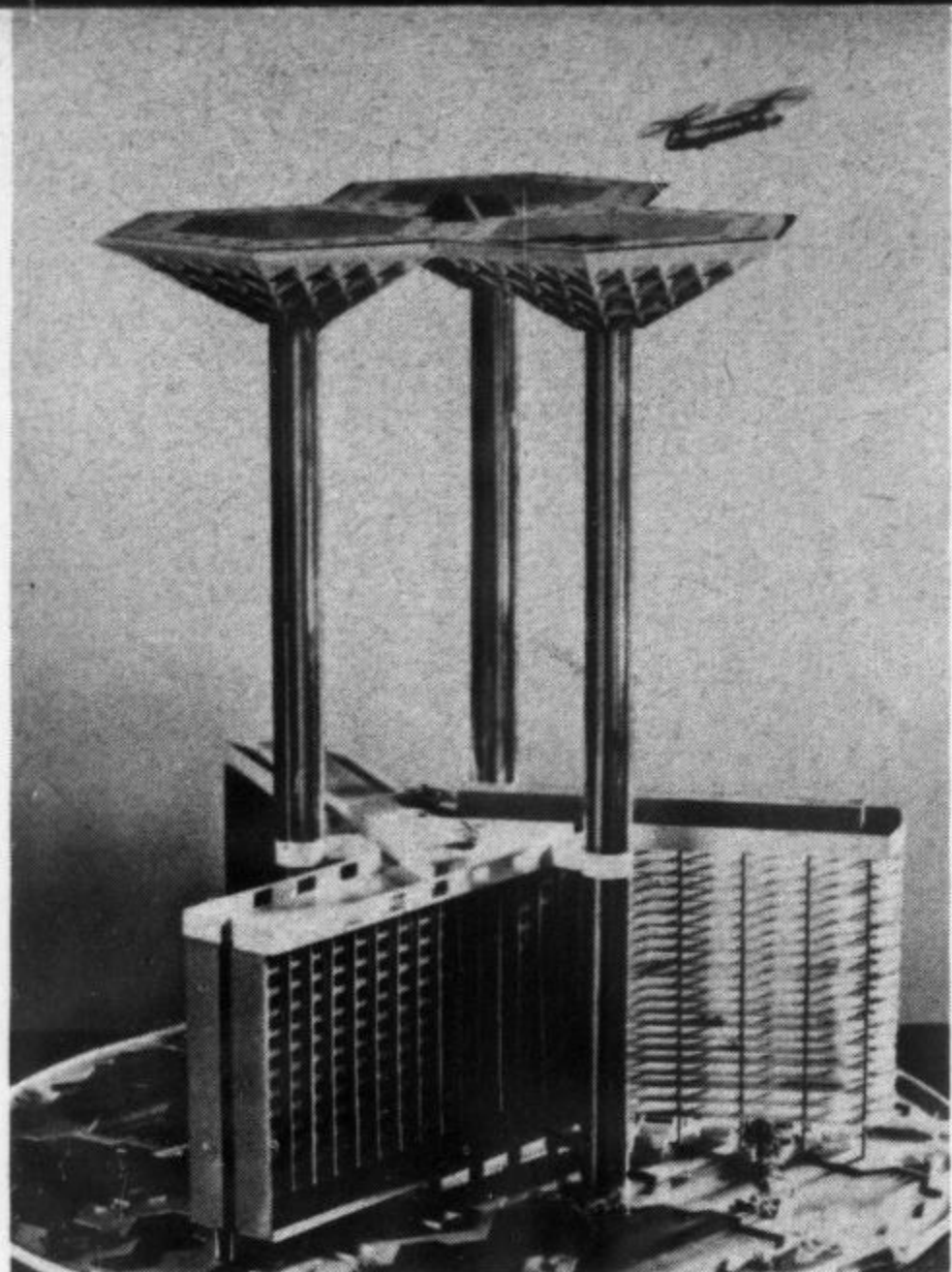


FIRST OFFICIAL USAF LUNAR CONTOUR MAP

This contour map, drawn on a scale of 1:1,000,000 with 1 inch equal to 25 miles, was prepared by the USAF's Aeronautical Chart and Information Center, utilizing the techniques described in the preceding article. This map may be removed from the magazine intact by turning to page 66, carefully removing the staples and then lifting out these pages.

THIS MAP CAN BE FRAMED AND USED AS A HANDY REFERENCE





The world of 1971

by ERNEST HAUSSMAN^N

Orbiting around the earth and sun today are more than a dozen man-made satellites and probes that were hurled into space with thundering rocket power. As of now, we on earth have experienced little more than a thrill of accomplishment when we hear the "beep-beep" from an orbiting satellite or watch Echo's shining path across the sky.

The new space age has barely begun to affect our daily lives. But the advances in science and technique engendered by our space effort are spreading into more earthly areas. And the next decade will see these developments utilized to significantly alter our way of living.

How will these radical changes be effected?

In a number of ways, not the least of which will be the purely economic repercussions of the mushrooming astronautic industry.

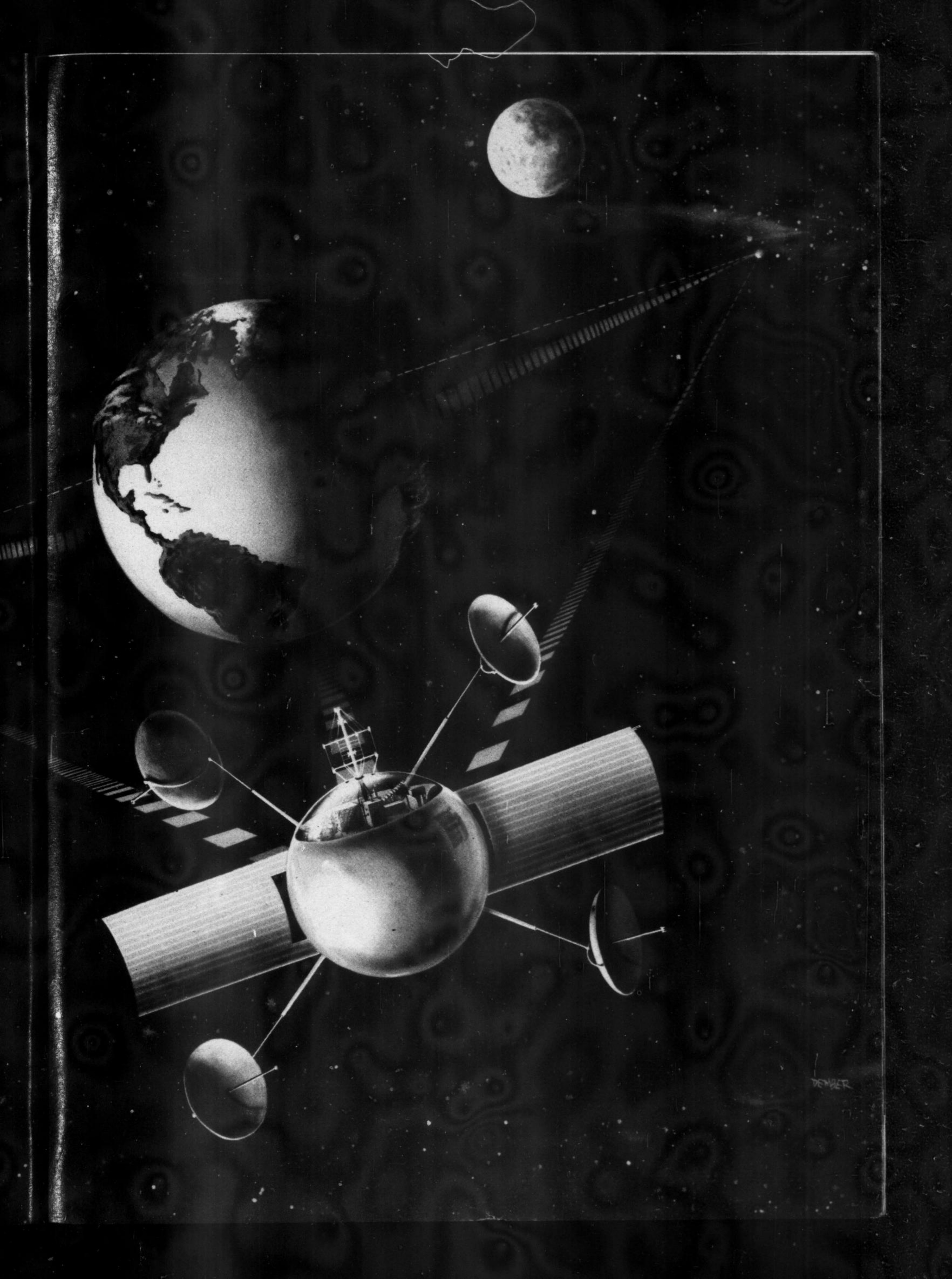
"The needs of our expanding space projects," says Congressman Erwin Mitchell, "have spread across the entire industrial spectrum—electronics, metallurgy, fuels and chemistry, metering instruments, ceramics, plastics,

(continued on page 30)

In the coming decade
space age technology will
make startling changes
in our way of living

COMMUNICATION SATELLITES.

Placed into a 24-hour orbit around the earth at an altitude of 23,000 miles, these radio relays will bounce radio signals to any point on face of earth.



DEMBER

By 1971 the space industry will be the largest in America

heavy machinery, textiles, thermals, cryogenics, and a thousand other areas."

Already, the field of astronautics has leapfrogged into fourth place in the U.S. industrial complex. At its ever-increasing rate of expansion, it is inevitably destined to be the single largest industry in America, dwarfing, before 1971, even Detroit's giant automobile industry.

Today, a minimum of 5,000 companies are directly or indirectly engaged in the rocketry business, and employ an army of more than 500,000 scientists, engineers, technicians and workers. More than 3,200 new products and devices are patented and produced annually in this program, and this rate shows every sign of continuing growth.

How will this affect you and your neighbors?

Industrial analysts Meyer M. Markowitz and Norman P. Gentieu point out that the expanding demand for new workers in space exploration and allied industries will help appreciably to take up the slack in jobs caused by industrial automation change-overs. And they add that the advanced technical nature of the industry demands

highly skilled, and therefore highly paid, workers. By 1971, astronautics will have gone a long way towards reducing the size of the unskilled labor force and will help expand the so-called middle classes to perhaps 80 per cent of the U.S. population.

It will mean a more prosperous, more educated, more technically capable population for the America of 1971.

Another development that will radically alter our lives in the next decade will be the increasing commercial utilization of the technical and scientific advances of the space age. This process has already started. There is hardly an industry in 1961 that has not begun to feel the energetic revitalization of research and production sparked by astronautics.

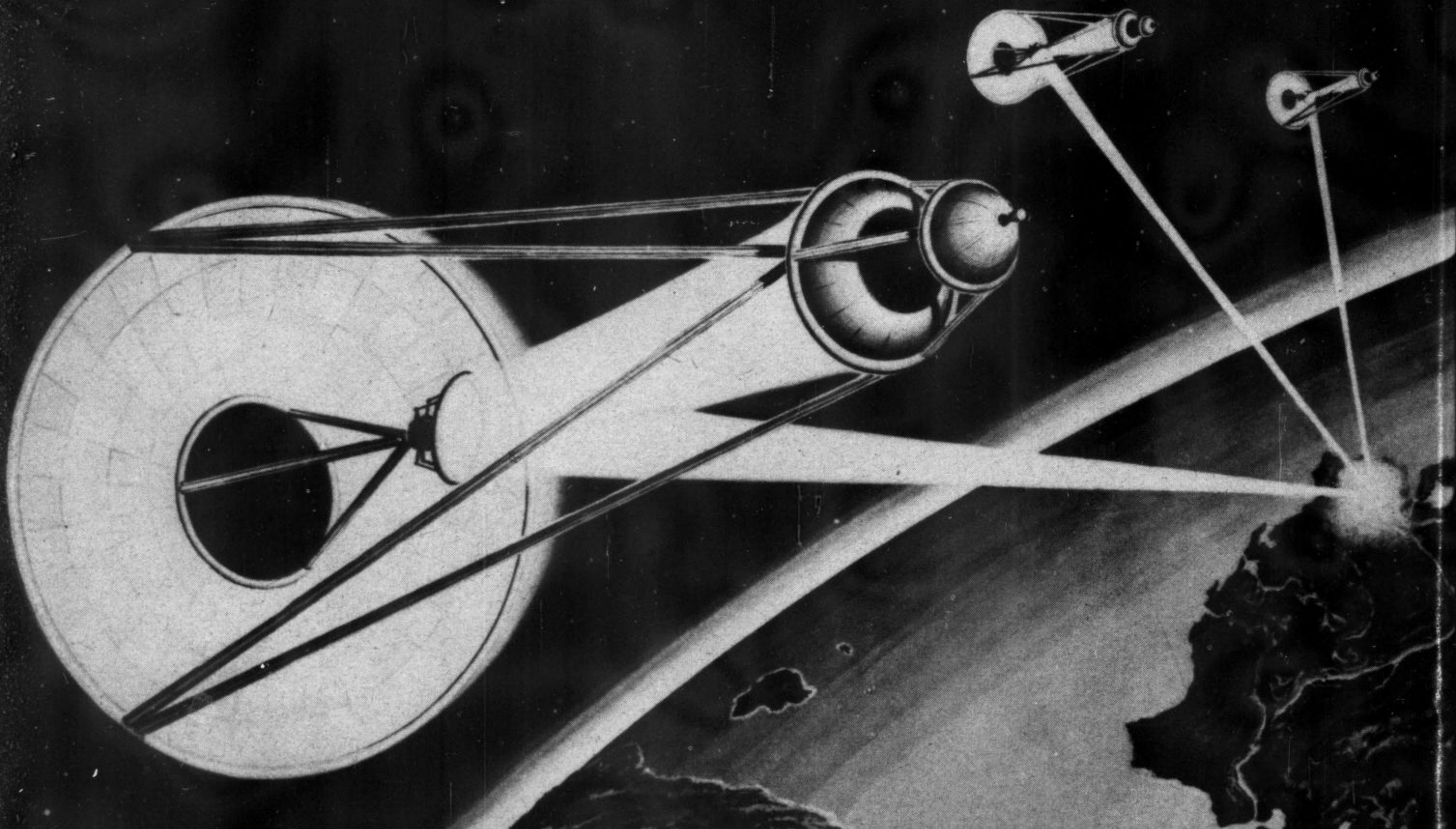
Spreading out like the waves from a pebble dropped into a quiet pool, the by-products of space research are rippling through many areas of commercial life. In turn, these industrial advances will sooner or later affect the lives of every ordinary citizen. Here are just a few examples of pure space techniques that are now being applied in diverse industries:

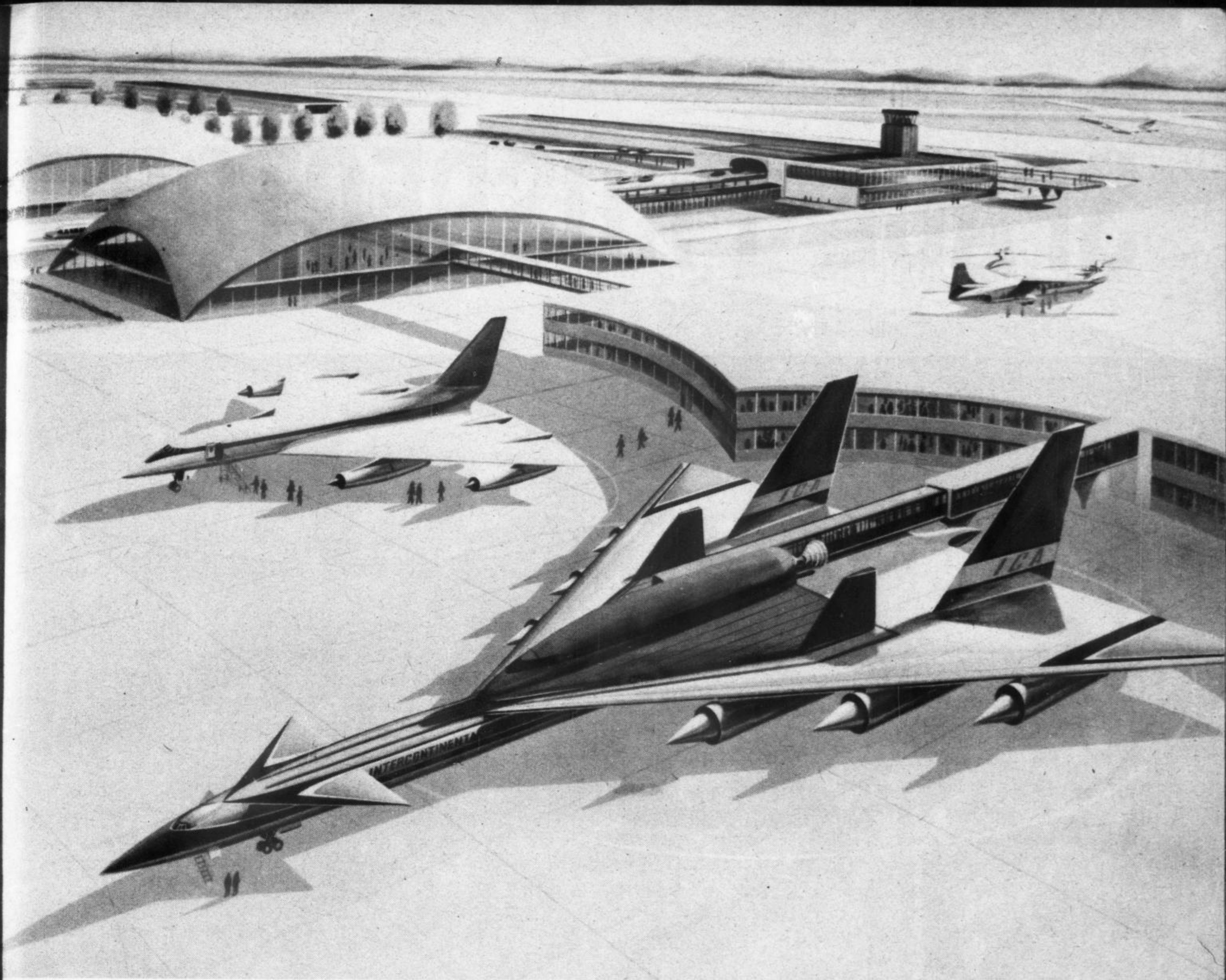
1. Experiments in the development of the nuclear plasma rocket engine are exploring the possibilities of a pro-

(continued on page 63)

WEATHER CONTROL. A unique climate-regulating technique proposed by Dr. Hermann Oberth suggests that we can influence

our weather by using large mirrors placed in orbit to reflect the hot rays of the sun to warm cold spots that develop below.



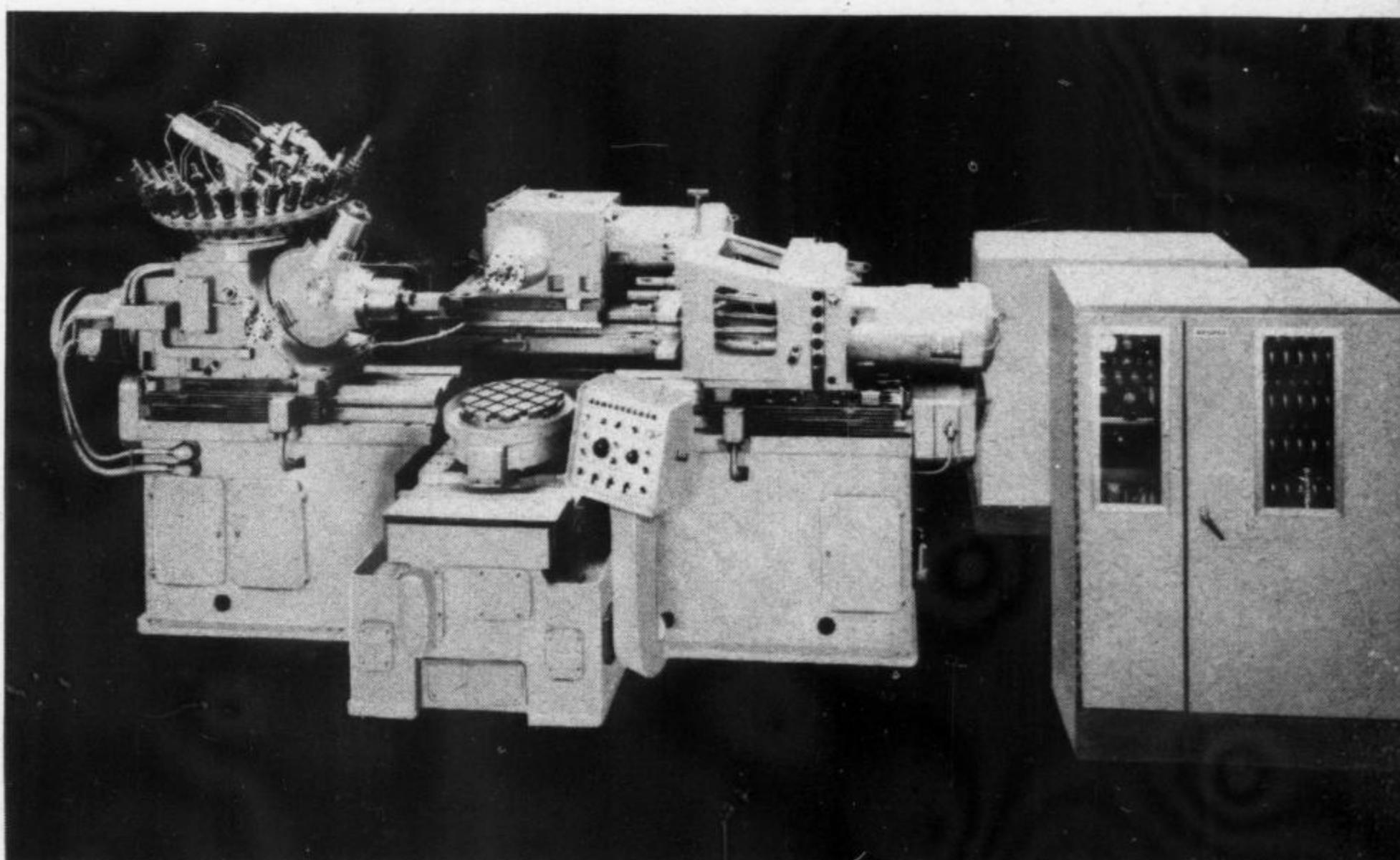


ROCKET TRANSPORT. Future commercial rocketliners will combine both rocket and jet power. First, a giant jet booster

will lift the rocket into the stratosphere where the rocket engines will take over and whisk passengers along at 15,000 mph.



MINIATURIZATION. Tiny radios, like this one above, utilize space technology.



AUTOMATION. Machinery that will be programed and operated by electronic computers, like this automatic tool lathe, are another dividend of the space age.

SPACE PROSPECTORS



INDEXED BY P.A.L.

Some further thoughts on commercial applications of space travel.

Here, an authority speaks about space treasures we might bring back

by WILLY LEY

Almost exactly 30 years ago a German engineer and I were standing on the proving ground of the *Verein für Raumschiffahrt* (Society for Space Travel) in Reinickendorf, Germany, watching the takeoff of one of the early experimental liquid-fuel rockets.

"Well," he said, when the small rocket dangled from its parachute some 1,500 feet over our heads, "it works as I can see. But what do you expect to do with it? I mean, what will finally make the money?"

I have often been asked this question—with variations and in several languages—since that day. My answer has depended to some extent on the year in which it was asked. On that first occasion in Reinickendorf, I spoke of my hopes for mail transportation by rockets, mentioned the idea of rocketry as a takeoff help for airplanes and said that there might even be earth transportation via passenger rockets. Finally, I talked about spaceships, to come in the far future.

After World War II, the answer to the question about commercial aspects of space vehicles shifted largely in the direction of useful satellites—TV-equipped satellites for better weather forecasts, others for navigational purposes, and still other satellites for long-distance communications. Of course, the city-to-city passenger rocket is still on the list of possibilities.

But the spaceship, until very recently, was considered essentially a device for scientific exploration, with little if any commercial possibilities.

When more practical aspects of spaceships have been mentioned to me, they were more likely to be in connection with social problems. For example, I have been asked repeatedly if the spaceship might not be the answer to the population explosion. Unfortunately, the answer is no. Even if the two nearby planets, Venus and Mars, were completely earth-like (which they decidedly are not) we would have to send a passenger ship seating 100 persons into space *every minute* just to stay even with the growth of the world's population.

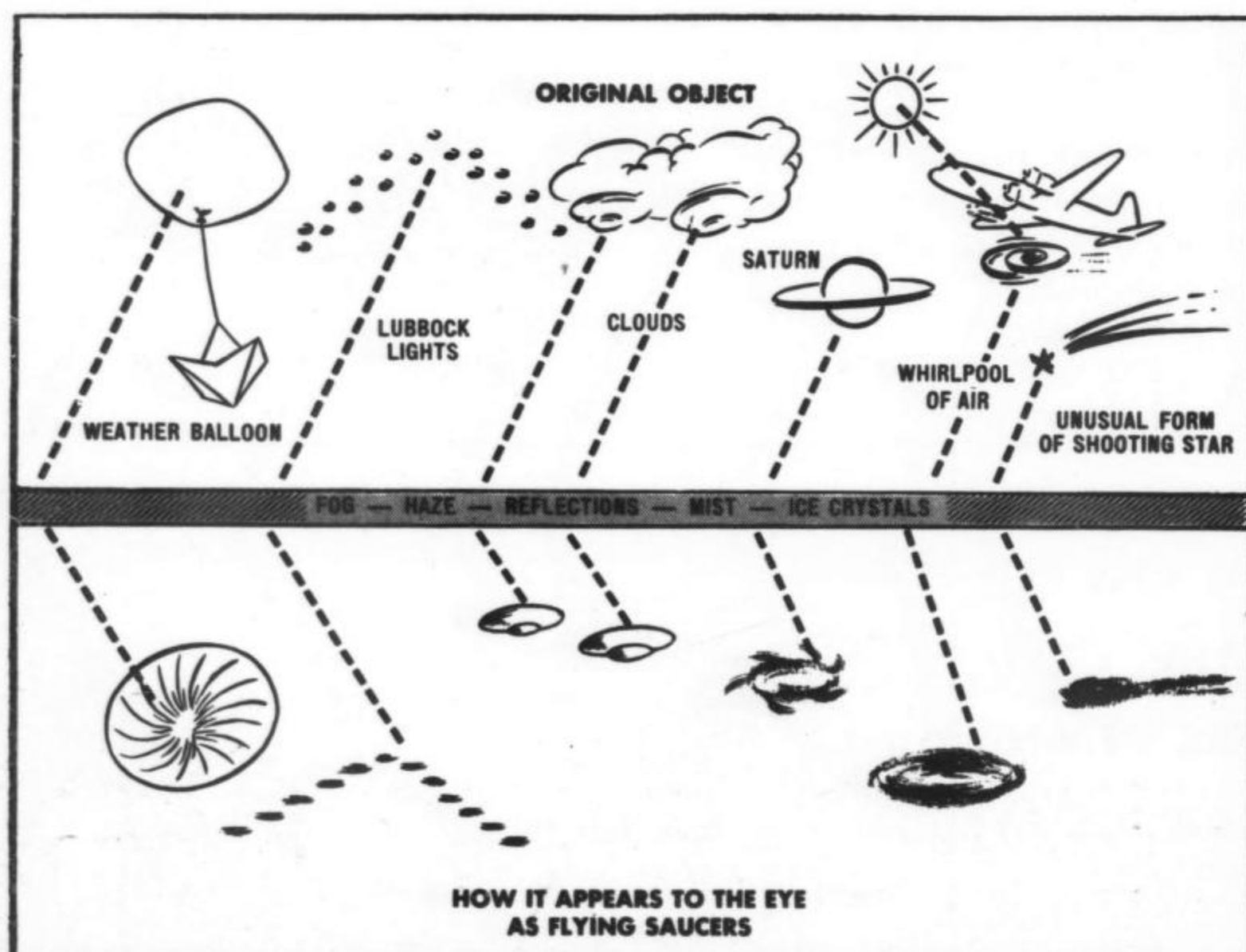
Well, what about the commercial possibilities of space? Does space commerce look promising? There can be no doubt that in a decade or two there will be manned bases on the moon and at least one on Mars. Whether there

(continued on page 52)

LUNAR BASE. Initial prospecting in space will result from actual construction of base facilities on the moon and the planets.



INDEXED BY P.A.L. 'FLYING SAUCER'



The editor brings you a report on UFOs that separates sense from nonsense

by OTTO O. BINDER

“WORLD SOCIETY OF FLYING SAUCERS!
I propose a Society devoted to nothing more than the search for an answer to the greatest aeronautical mystery of all time . . .”

This advertisement appears in a bi-monthly magazine devoted solely to flying saucer phenomena. The ad was inserted by Kenneth Arnold, who inadvertently started the entire flying saucer mystery that has reverberated across America for almost 14 years.



FLYING SAUCERS? These unworldly-looking objects are really common cloud formations.



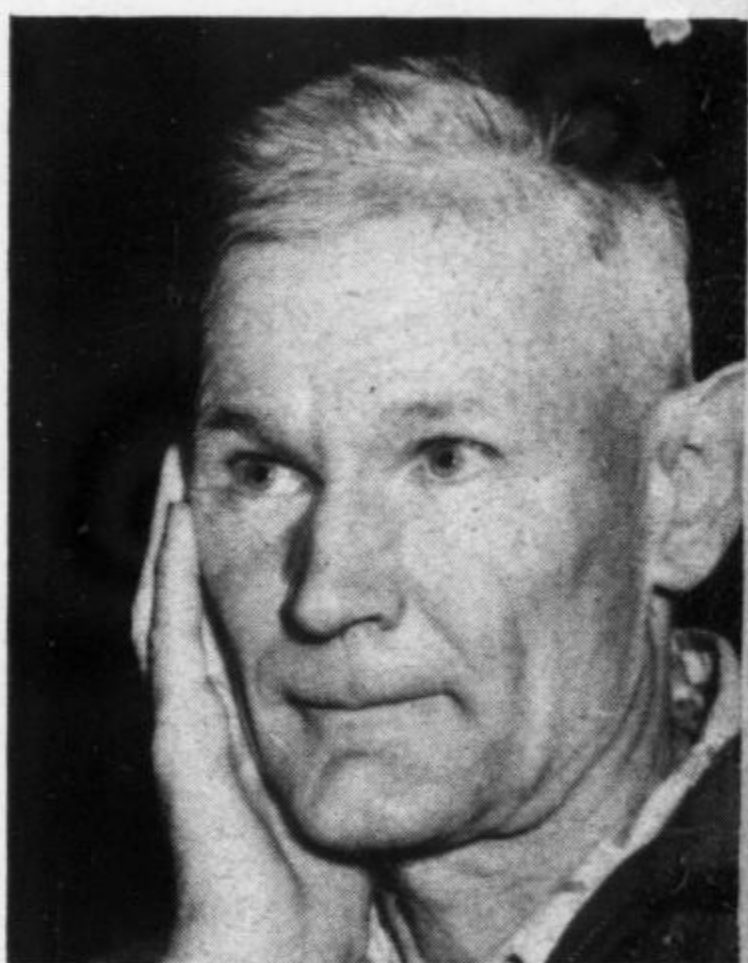
Desmond Leslie wrote book on alien UFOs that landed on earth.



Kenneth Arnold 'saw' the first flying saucers on June 26, 1947.



Donald Keyhoe, ex-Marine Col., says UFOs come from space.



Buck Nelson, 'visited' Venus, and Mars aboard flying saucer.

PHENOMENA

It was in June, 1947, that Arnold, employed by a business firm in Idaho, was flying his private plane near Mount Rainier in Washington. Suddenly, he saw nine flying objects. "I watched for about three minutes a chain of saucer-like things . . . swerving in and out of the high mountain peaks," he reported later. "They were flat like a pie pan and so shiny they reflected the sun like a mirror. I never saw anything so fast . . ."

It was the newspapers, not Arnold, that invented the term "flying saucers". Only a few days later, reports began coming in of more flying saucers sighted by impressionable people everywhere. The sky, once so serene, was suddenly full of flying disks, whirling dinner plates, domed pancakes and a wide variety of such queer craft.

The U.S. Air Force was ordered to investigate the possibility that some new form of foreign aircraft was surreptitiously crossing American airspace. It quickly became apparent from the reported speeds of over 1,000

mph (this was before the supersonic barrier had been broken) and the sharp-corner turnings, that no earthly technology could have created these vehicles.

The official term then became UFO, Unidentified Flying Objects. All reports were processed through the ATIC (Aerospace Technical Intelligence Center) of the Air Force. From 1947 to date, there have been over 6,000 sightings of the mysterious "craft" in America. UFO fans claim a total of at least 15,000, plus many more thousands from other countries.

Is Seeing Believing?

The official story is told in a new book, "Flying Saucers and the U. S. Air Force". According to the author, Colonel Lawrence J. Tacker, the vast majority of sightings proved to be illusions involving peculiar weather conditions or familiar objects seen in distorted form. Typical

(continued on page 61)

SPACE

WORLD

The Magazine of Space News

JUNE 1961
VOL. 1, NO. 8

The Russian Venus Probe

Can Man Survive in Space?

America's New Super Rocket

Engineering a Mars Colony

Dr. Wm. Helvey: Space Medic

A New Approach to Telemetry

FINAL CHECK-OUT
FOR MERCURY CAPSULE

Wernher von Braun

Fred Whipple

Willy Ley

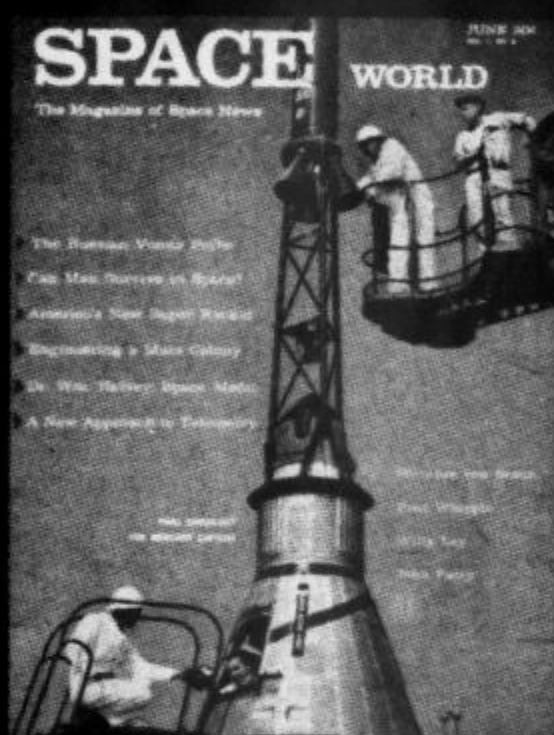
John Parry

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JUNE 1961
VOL. 1 — No. 8

SPACE WORLD

ABOUT THE COVER



Technicians make a final check on Mercury Capsule before test flight via a Little Joe launch. These preliminary tests will be followed by manned orbital flight utilizing the Atlas ICBM as booster.

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CONTENTS

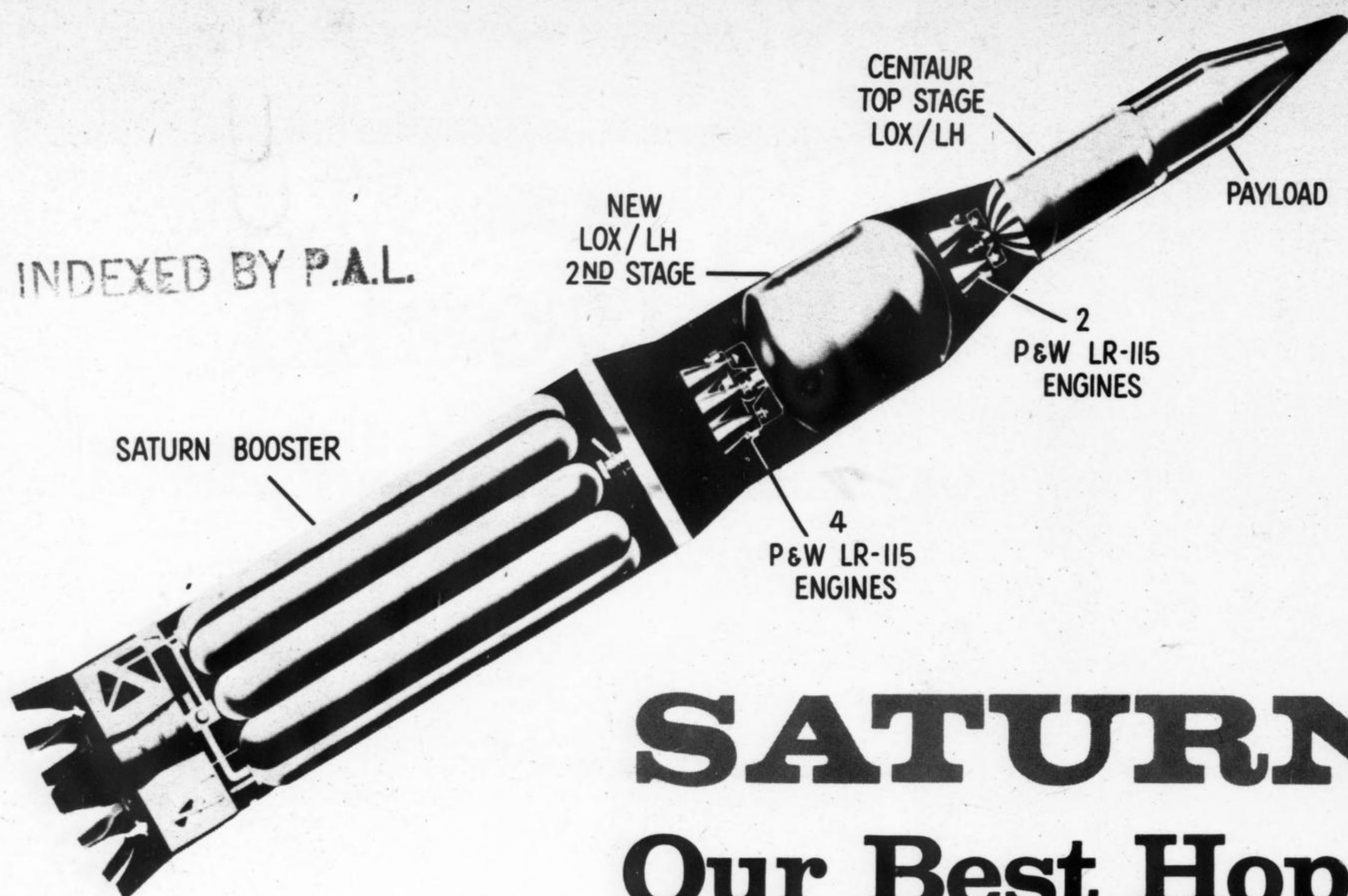
ARTICLES

- 10 **SATURN: OUR BEST HOPE**, by **Wernher von Braun**
A detailed report by the chief architect of America's biggest booster.
- 14 **KITCHEN IN SPACE**, by **Ernest Haussman**
Engineering a kitchen for a manned space vehicle has unique problems.
- 18 **THE HUMAN FACTOR**, by **John Rublowsky**
An interview with Dr. William Helvey, leading space medicine authority.
- 20 **DUST HALO**, by **Fred L. Whipple**
Our foremost astronomer discusses the earth's newly-discovered corona.
- 23 **HOW IT ALL BEGAN**, by **Willy Ley**
The author recalls the first days of the space age when rocketry began.
- 26 **THE REFRACTIVE APPROACH TO TELEMETRY**,
by **John Parry**
A leading engineer describes a innovation in telemetric techniques.
- 30 **MARS COLONY**, by **Otto O. Binder**
After the moon, Mars is the next most likely body to be visited by man.
- 32 **THE PROBLEM OF SURVIVAL**, by **Harold L. Bloom**
Complex life-saving gear is being designed for our manned space probes.
- 36 **WHO OWNS WHAT?** by **William Hyman**
A legal authority examines current anarchy in international space law.
- 40 **PIGGY-BACK TO VENUS**
Report on the Russian Venus probe launched from an orbiting satellite.

DEPARTMENTS

- | | |
|-------------------------|----------------------------|
| 4 LETTERS TO THE EDITOR | 43 BOOK REVIEWS |
| 6 ORBITING AROUND | 45 SPACE VEHICLE #2: ATLAS |
| 22 WHAT'S NEW | 47 RUSSIAN REPORT |
| 29 NAMES IN THE NEWS | 49 SPACE QUIZ |

INDEXED BY P.A.L.



SATURN

Our Best Hope

A progress report on America's most powerful rocket engine

by WERNHER VON BRAUN

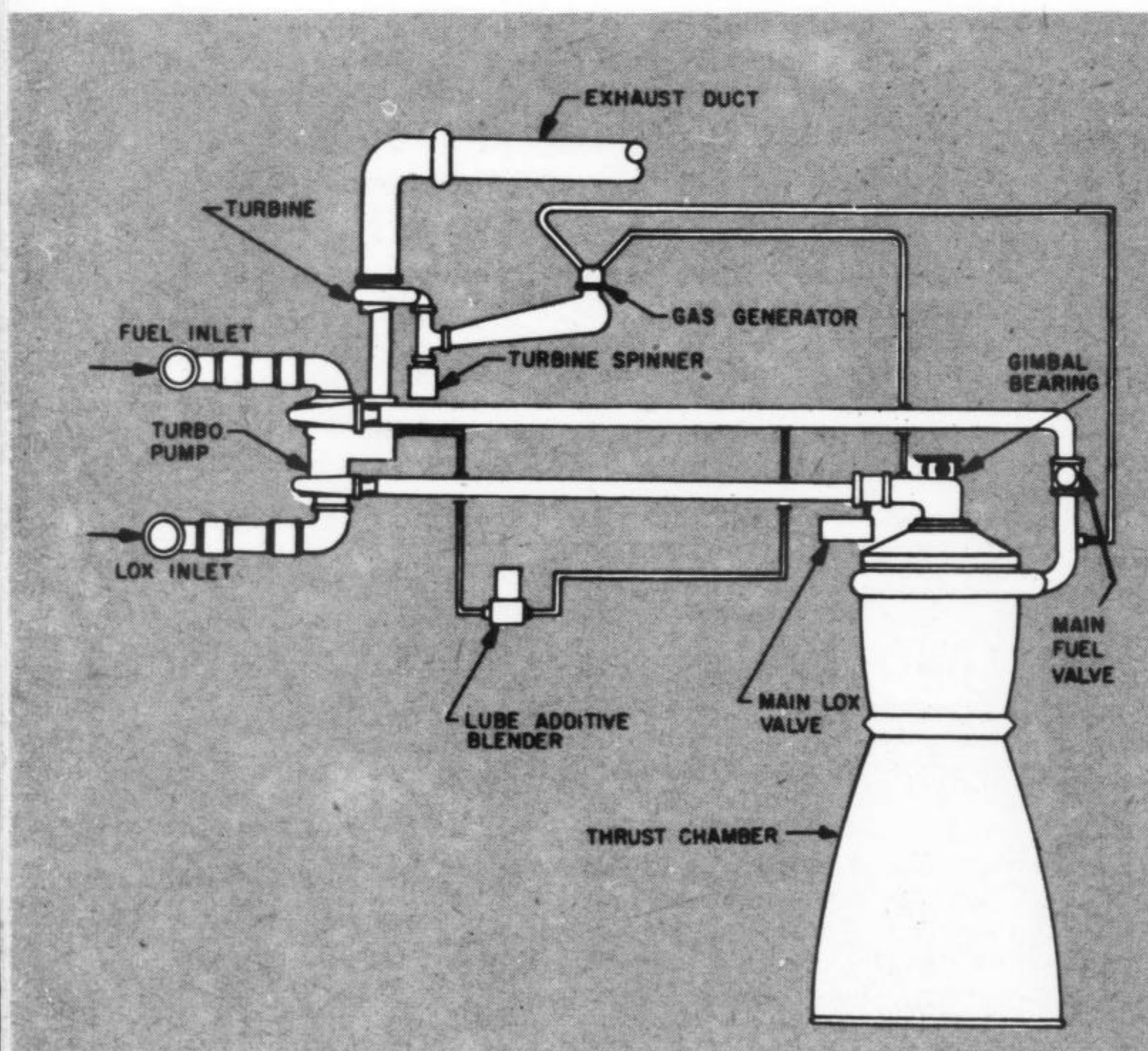
It is rather incredible, when you give it a little thought, to realize that man has burst through a whole new frontier . . . the fringe of outer space . . . in the short time of 42 months.

During these historic months man has circled the earth with over two dozen artificial moons, lifted tons of payload into space, taken pictures of the moon's other side, sent satellites around the sun, garnered unsuspected information about radiation belts, and uncovered many additional bits of significant knowledge.

These early explorations of the wonders in the Universe have been achieved, as we all know so well, by both the Western World and the Soviet Union. Mankind, as a whole, can be proud of this first physical incursion into the cosmos. He can look forward with full confidence to many more revealing discoveries that will not only enrich his store of knowledge, but will without question help him to live happier and longer.

Early Generation Carrier Vehicles

I should like now to give you a rather more intimate insight into some of the contributions the United States



H-1 ENGINE CONFIGURATION. A modified Jupiter S-3D booster, the Saturn H-1 has less than half the parts of its parent engine.



THE AUTHOR. Director of the Marshall Space Flight Center, Dr. Wernher von Braun is the principal architect of Saturn.

has made to the conquest of space . . . particularly with regard to space carrier vehicles . . . and to tell you how we propose to extend those efforts.

In the United States, our two first-generation carriers were the well-known Redstone-based Juno I (Jupiter C) and the Vanguard. These vehicles orbited six Explorer and Vanguard satellites, four of which are still in orbit—Explorer I and the three Vanguards. No longer in service, these boosters were minimum vehicles, with net payload orbiting capabilities ranging from 20 to 50 pounds.

Our second generation carriers include the Jupiter and Thor IRBM-based systems still in use. The Thor-Able space carriers lifted Pioneer I out towards the moon in late 1958, launched the Explorer VI and Tiros I satellites, and injected Pioneer V into an interplanetary trajectory. Communications with this probe were maintained for about 23 million miles.

The Thor-Agena A has proved a very successful vehicle and has placed over a dozen Discoverer satellites into orbit. Thor Epsilons (Thor-Able Star) have orbited Transit 1B and 2A navigation satellites, and Courier 1-B radio-relay. As for Jupiter-based vehicles, the Juno IIs are well known for launching the Pioneer III space probe, Pioneer IV artificial planetoid, the highly instru-

mented Explorer VII satellite, which has provided reams of data for 1½ years and is still transmitting, and Explorer VIII, the so-called "radiation laboratory."

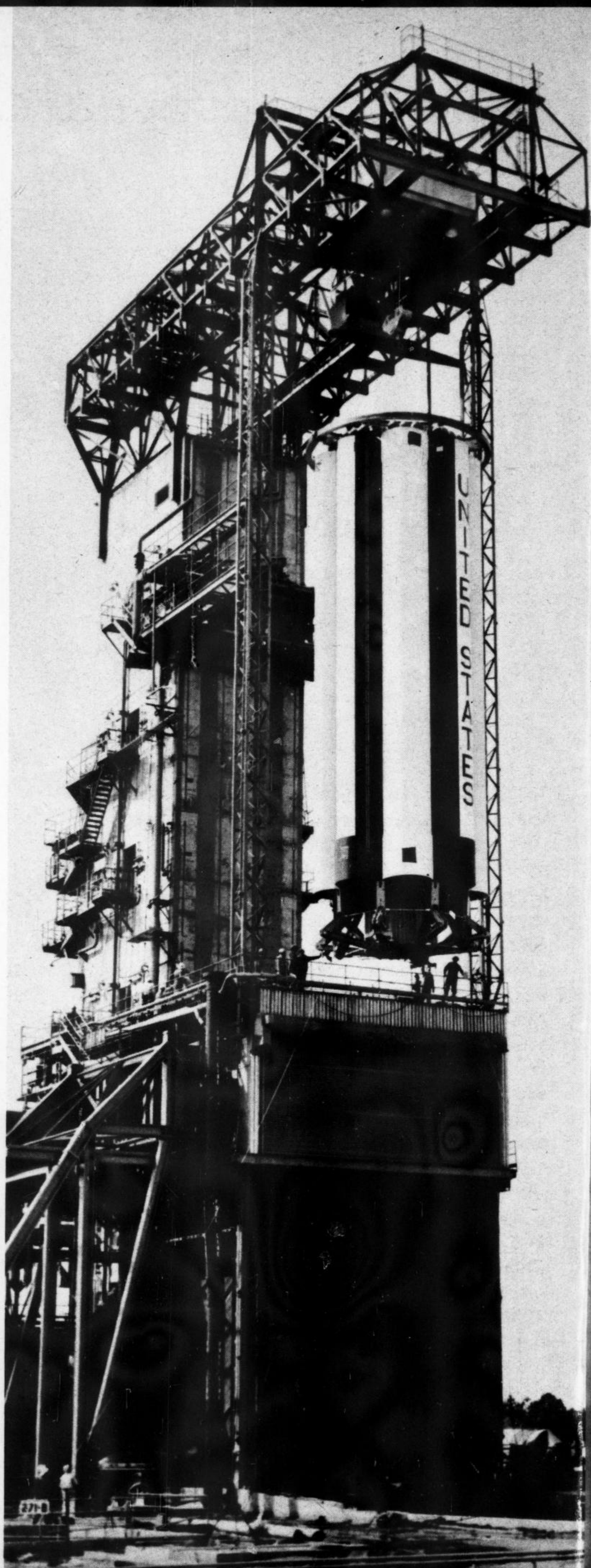
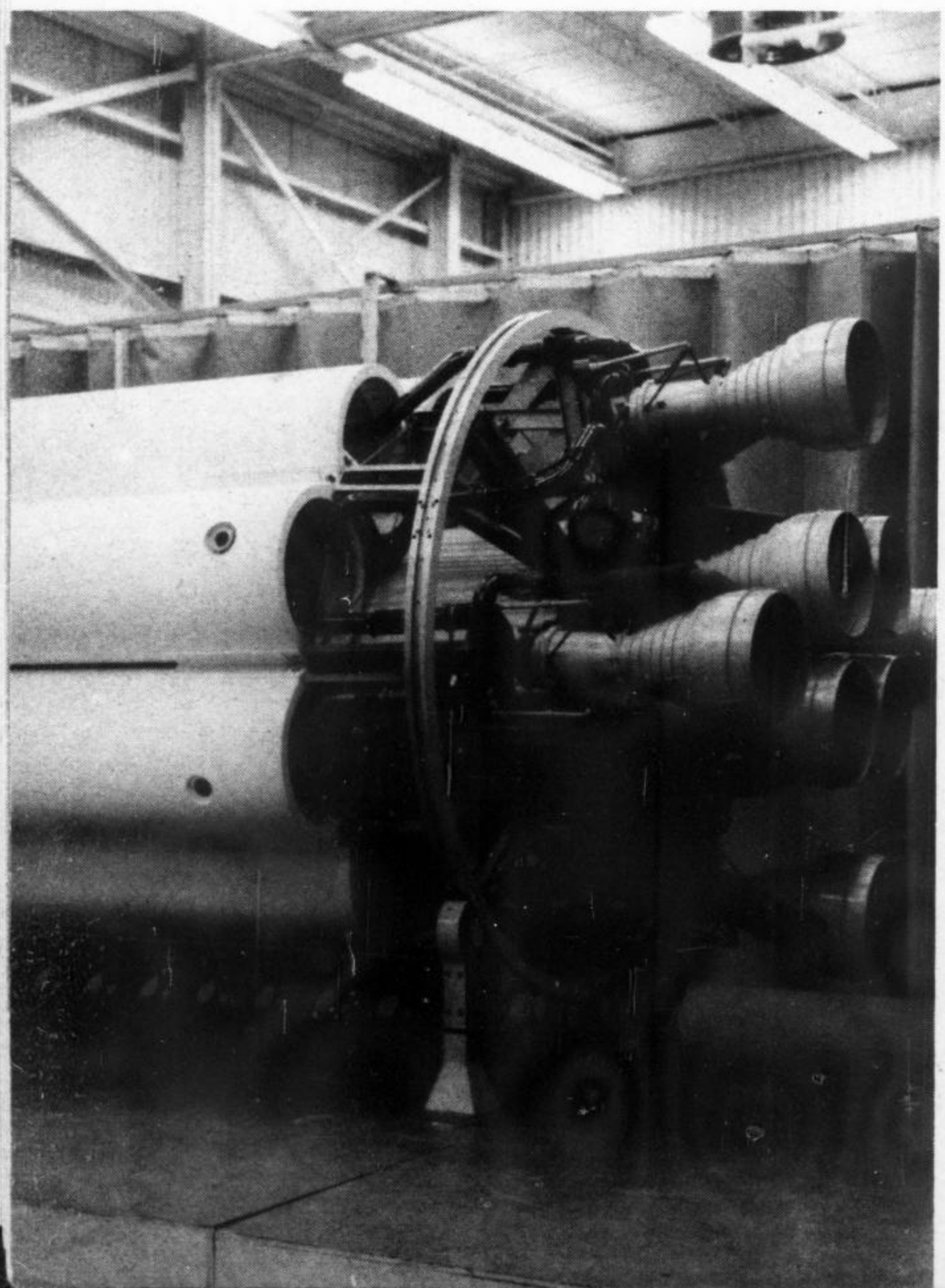
As an interim phase leading into our third-generation space carrier systems, the development and test-flight program of Atlas-based vehicles is progressing rapidly. In the 1958 Project Score experiment, Atlas proved capable of "lifting itself" into orbit with a communications payload weighing well over 100 pounds. Atlas-Mercury, also without active upper stages, is being readied for manned capsule assignments, while Atlas-Able has been tested in several lunar firings. On May 24, 1960, the Atlas-Agena A successfully orbited a satellite (Midas II) payload, weighing more than one ton, in a nearly circular 300-mile 96-minute orbit.

Third-Generation Boosters

Four vehicles under advanced development by the NASA comprise the third-generation U.S. space carriers. One of these, the all-solid propellant Scout, is designed for small payloads. Thor-Agena B's and Atlas-Agena B's, extrapolations of Thor/Atlas/Agena A's, possess significantly increased payload capabilities. Furthermore, their second stage engines can be cut off and reig-



UNDER CONSTRUCTION. H-1 rocket engines, above, are inspected at Rocketdyne plant before shipping to Huntsville. Eight H-1 engines are clustered on Saturn air frame (below). Final step in production takes place on giant gantry (right) where the assembly undergoes static firing tests.



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Saturn is now in its first testing program

nited in space in accordance with programed instructions.

The Atlas-Centaur includes many striking refinements and represents an advanced version of an Atlas-based system that is scheduled to carry heavy payloads into earthly orbit, on to the moon's surface, and out toward the planets.

Scout is designed to lift a 100-pound net payload to nearly 4,000 miles as a sounding rocket, or place 150 pounds into a 300-mile orbit.

The upper stage of the Thor-Agena B has twice the propellant tank capacity of the Agena A and can be restarted in space to maneuver a useful payload of over 1,000 pounds into a desirable 300-mile orbit. Mated to an Atlas, the Agena B can boost a 5,800-pound satellite into this orbit, as well as impact over 700 pounds onto the moon.

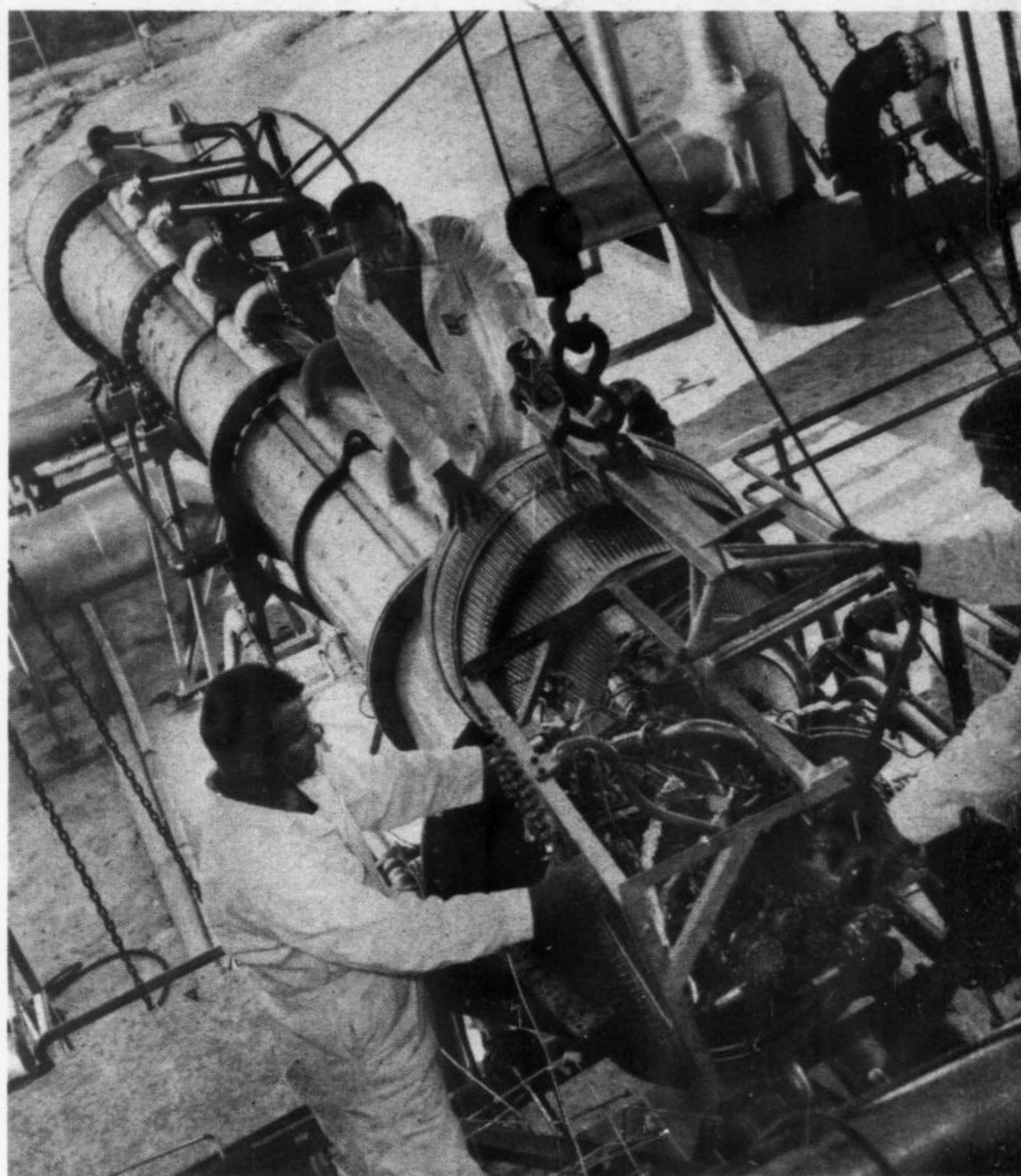
The Centaur stage is powered by twin liquid oxygen/liquid hydrogen rocket engines which can be ignited in space, cut off, and refired several times in accordance with programed instructions from the guidance system. The Atlas-Centaur mating is designed to carry some 8,500 pounds into a 300-mile orbit, or impact 2,500 pounds into the moon and soft land on the order of 700 pounds. It could hurl over 1,000 pounds into a Mars or Venus trajectory.

Reviewing the Saturn program's history, it started as early as the Spring of 1957 when our preliminary designers were studying a large, clustered-engine first stage arrangement. In the late summer of 1958 we were authorized to proceed with the design and development of a 1.5-million-pound thrust stage based on this bunching concept.

A cluster of Jupiter and Redstone diameter tanks was selected for use with the propulsion system utilized in early tests. This approach allowed the existing tools and experience accumulated to benefit the program.

The original concept of a four Rocketdyne E-1 engine cluster was modified to eight H-1 engines of 188,000 pounds thrust apiece because of the cost and time involved in bringing the more powerful (360,000 pounds thrust) E-1 engine to an operational status. The H-1 engine, an advanced offspring of the S-3 Jupiter/Thor engine, was selected because of its relative simplicity and expected early availability. By November 1958 we were given the go-ahead to build four flight test vehicles.

In preliminary planning, the first approach was to examine what could be done with already-proved IRBM and ICBM hardware. Several configurations seemed promising but were not optimum from a performance standpoint. In time the Centaur program was underway,



SATURN UPPER STAGE. Technicians prepare to test XLR 115 liquid hydrogen rocket that will be used as Saturn third stage.

and since the use of high-energy propellants in one or more Saturn upper stages was most desirable, the Centaur design was studied along with the ICBM hardware.

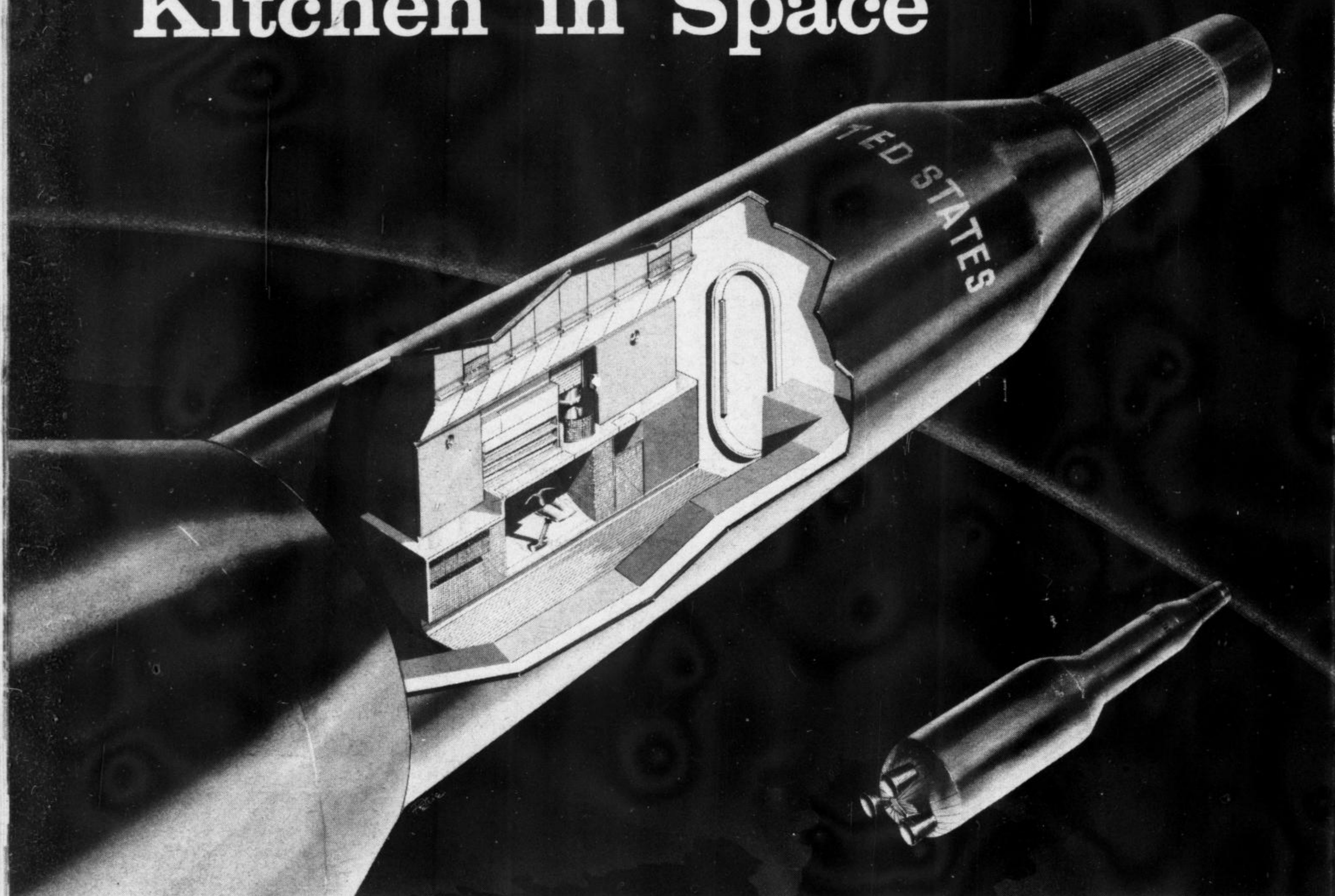
Evolving from those 1958-59 studies came the decision to use high-energy propellants in all upper stages of Saturn. This not only will add considerable payload capability but also allow for the interchange of upper stages as new and more powerful engines are developed or additional upper stages are required.

Saturn is based on what we call the "building block" philosophy . . . using proved stages from our early Saturns as integral parts of advanced Saturns. For example, the potential advanced configuration called C-2 results from the addition of one upper stage, or building block, to the C-1 three-stage configuration.

The first C-1 configuration, presently being developed at Huntsville, is expected to be operational by 1964. It will be approximately 185 feet high, weighing about 1,160,000 pounds when fueled and poised for lift-off from the pad. Of this weight, almost 1,000,000 pounds

(continued on page 42)

Kitchen in Space



INDEXED BY P.A.L.

**Novel techniques will be used
to feed the traveler in space**

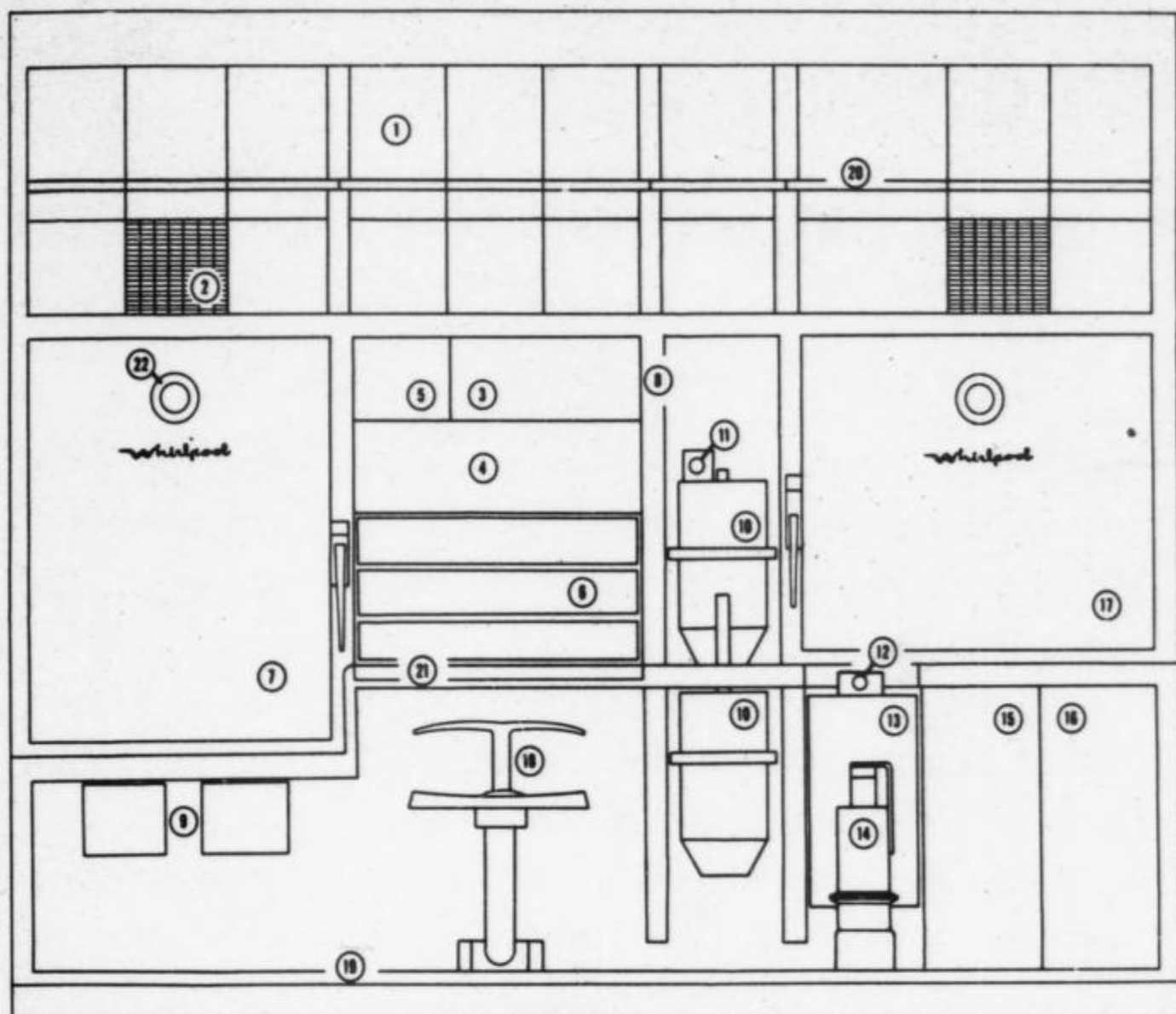
by **ERNEST HAUSSMAN**

It is a sad fact of life that getting three square meals a day will not be easy in a spaceship. The astronaut can't pull up a chair to a table loaded with tasty foods. Not only are the chair and table out, but so are plates, cups, bowls, spoons and other normal paraphernalia of eating.

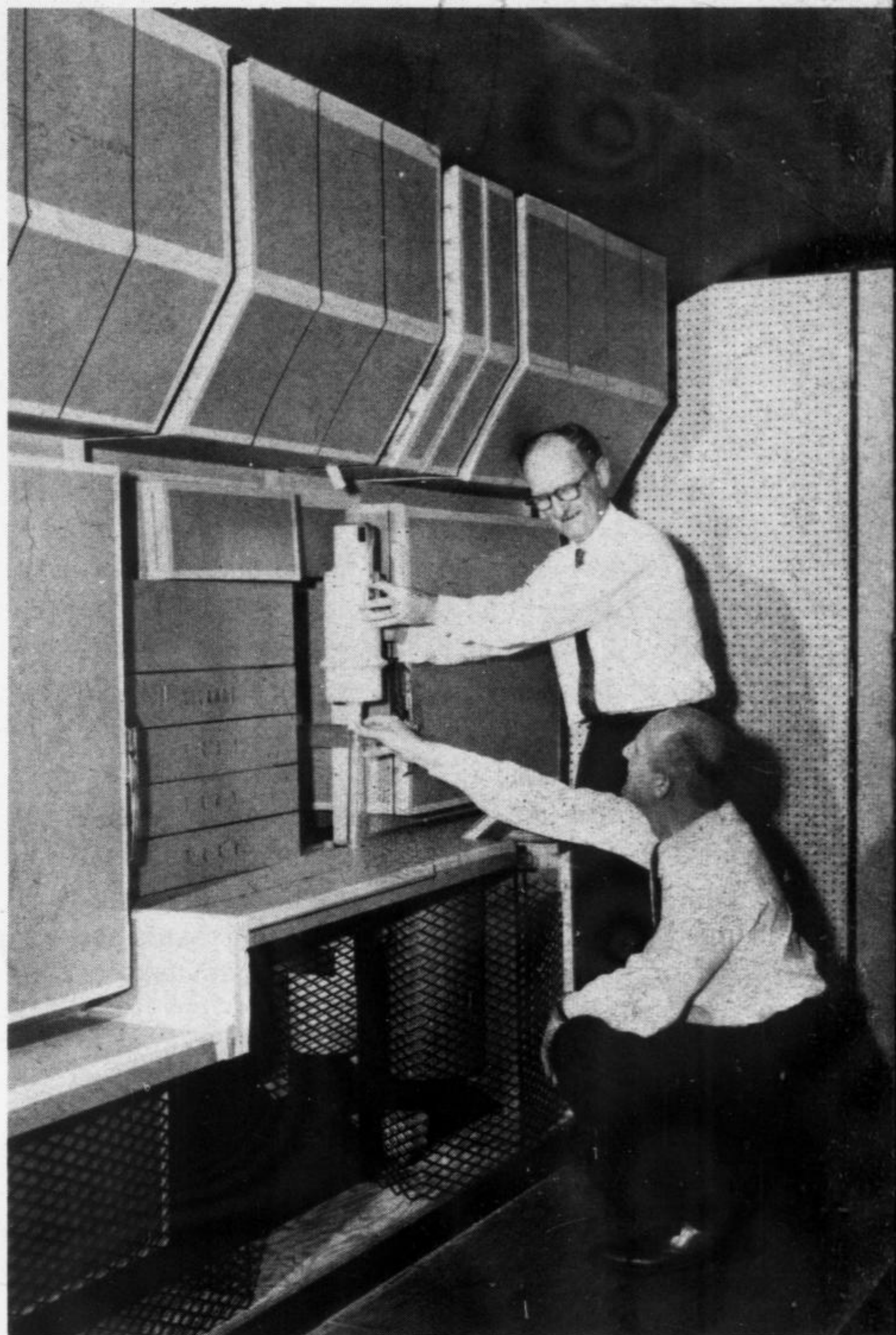
A serving of steak and onions with French fries is an astro-impossibility. Even a simple cup of coffee . . . in a *cup* . . . is an earthly luxury, unattainable aboard any ship in orbit or on its way to outer space.

For these reasons, gourmets have been advised to stay out of space. This culinary tip comes from Howard Brehm, Research and Development Project Coordinator of a firm making home appliances. He says: "During space flight, the kitchen, the men and everything else within the manned vehicle would be absolutely weightless once rocket power is shut off. Any efforts to prepare a recipe or cook a meal during this trip would not only be sheer folly, but could be disastrous."

Brehm goes on to picture the catastrophic results if an attempt to cook a meal were made: "Foodstuffs, cans, pots and pans, butcher knives, sharp-pronged forks, hot grease, boiling water . . . everything would be floating around in mid-air within the cabin. If at the same time the pilot had to use the vernier rockets to change course, the ship's turning would cause the utensils to fly around violently, ricocheting from each other, from the walls . . . and from the heads of the astronauts. Even if the crew did escape unharmed from the ava-



SCHEMATIC VIEW. *Space Kitchen is designed to feed 3 men on 14-day mission. 1—Dry food storage bins that latch at top and pull down on pivot. 2—Air ducts. 3—Oven. 4—Storage compartment for eating equipment. 5—Glove and pad storage. 6—Feeding trays. 7—Freezer. 8—Support. 9—Thermoelectric power units. 10—Cold water tank. 11—Cold water tap. 12—Hot water tap. 13—Hot water tank. 14—Portable water tank. 15—Wet waste storage. 16—Dry waste storage. 17—Refrigerator. 18—Foldaway chair with knee clamps. 19—Toe hold bar. 20—Grab bar. 21—Storage counter top. 22—Temperature gauges. H. Brehm, kneeling (r.) examines mock-up with W. Saenger.*



lanche, there's no telling what damage it would do to delicate flight instruments, the oxygen/breathing system, or even the inner walls of the vehicle's structure."

This distressing problem has also been recognized by the men running our space program. Recently the Wright Air Development Division (WADD) of the USAF's Air Research and Development Command (ARDC) awarded a contract to Howard Brehm's firm, the Whirlpool Corporation of St. Joseph, Michigan, to design and build America's first *Space Kitchen*.

Home-Appliance First

A long line of American industries has been gradually pulled into the space effort . . . the makers of airplanes, jet-engines, chemical fuels, sheet metals, instruments, plastics, gyroscopes, and many more.

But the WADD experimental project in space cooking marks the first time a home-appliance company has received an astronautics assignment.

Whirlpool's contract calls for the development of a unit which can provide all foods and beverages required by three space pilots on a 14-day mission. The Space Kitchen is to occupy an area approximately 10 feet long and 7½ feet in diameter, in the forward section of a multi-stage booster. This manned upper stage, whether a capsule or winged craft, will be proportionately large enough to accommodate the kitchen without crowding the crew.

Specifications for the Space Kitchen include three basic components that any chef would need:

(1) A miniaturized refrigerator plus deep-freeze compartment, run by a thermoelectric unit (probably the fuel cell now being perfected to generate electricity via heat-cold principles);

(2) A three-cavity oven; and

(3) A built-in water system of 2½-gallon capacity with its own heater to provide hot water as needed.

However, Project Coordinator Brehm points out,

Unit will provide 14-day sustenance for 3 men

none of these appliances will be used in the same manner as their earthly counterparts.

Choosing The Menu

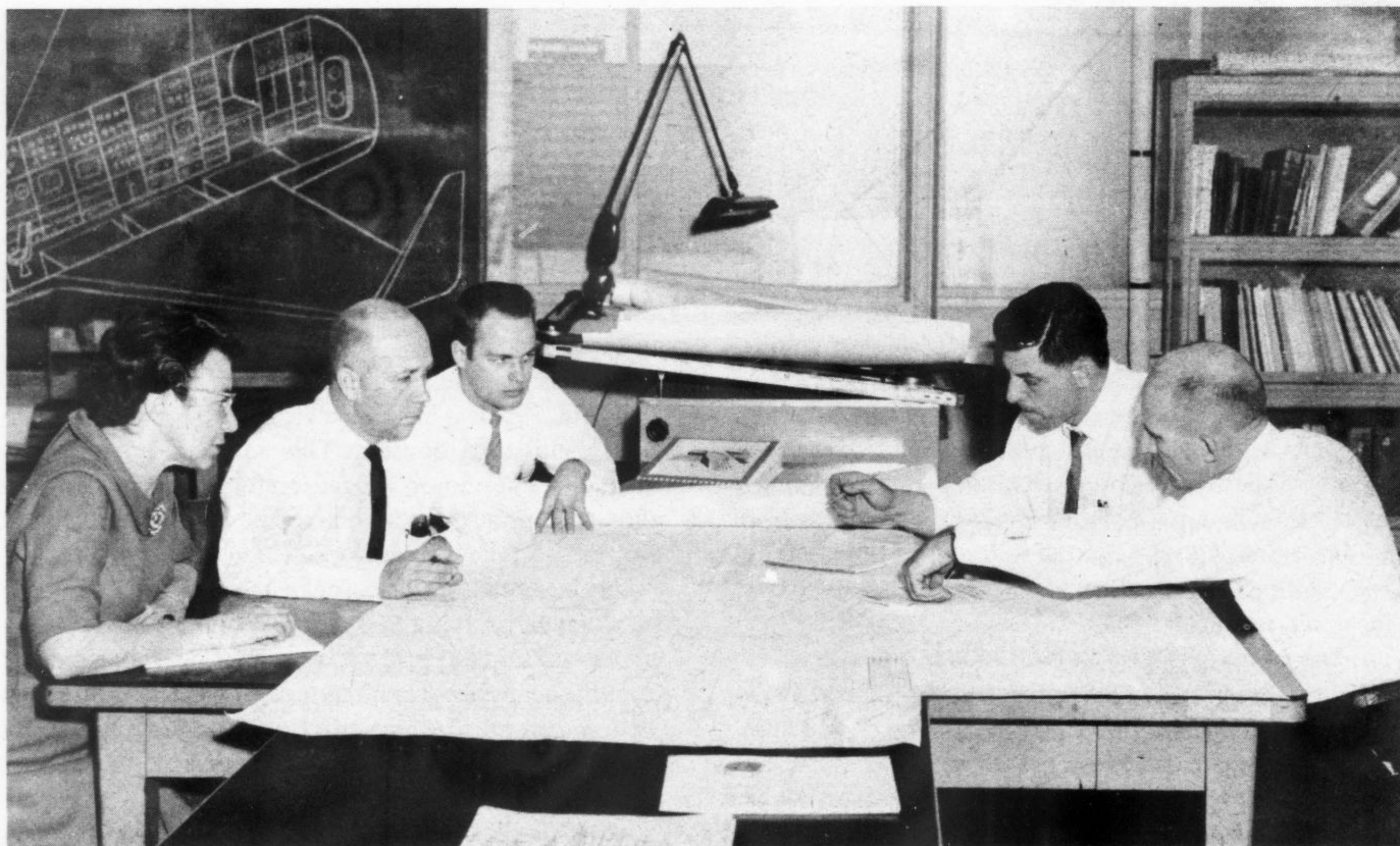
Because of the problem of zero gravity, the Space Kitchen will function as a food-dispensing center rather than a food-preparing unit. While such familiar snack items as candy, nuts, cookies, cakes, and bite-size sandwiches will be available to the spacemen, much of the mealtime food will be in pre-processed or dehydrated form, and packaged in disposable containers resembling over-size toothpaste tubes. Other foods for which squeeze-tubes are not feasible—ham and eggs, curried chicken, swiss steak, vegetables and miscellaneous solids—will come in canned form.

During the flight, selection of solid foods and whatever preparation they might require will be a simple matter for the space diner. Choosing his menu—break-

fast, lunch or dinner—the astronaut will place any food containers requiring heat in the Space Kitchen's oven. Within 30 minutes, this heating device will warm the food to 175 degrees.

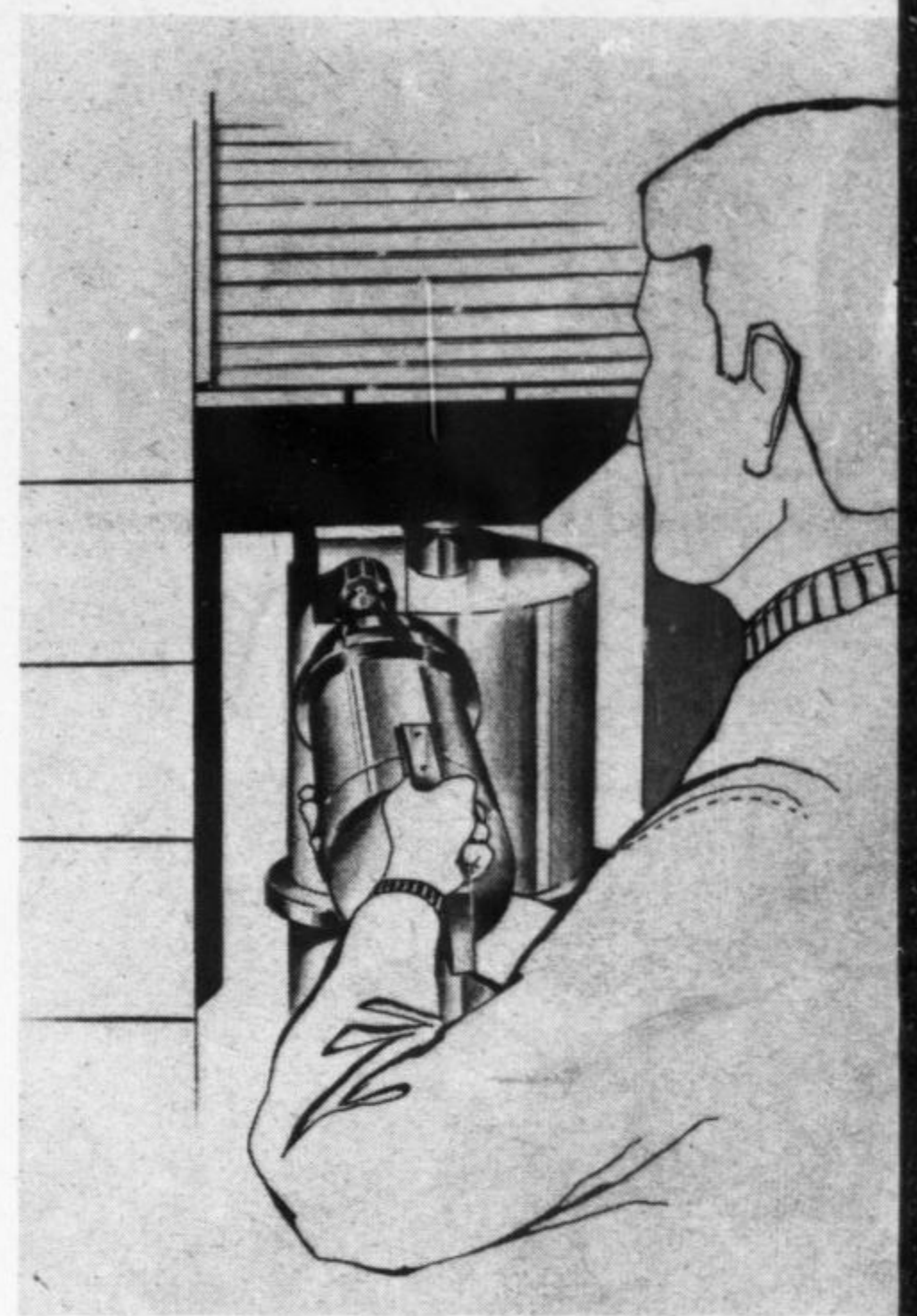
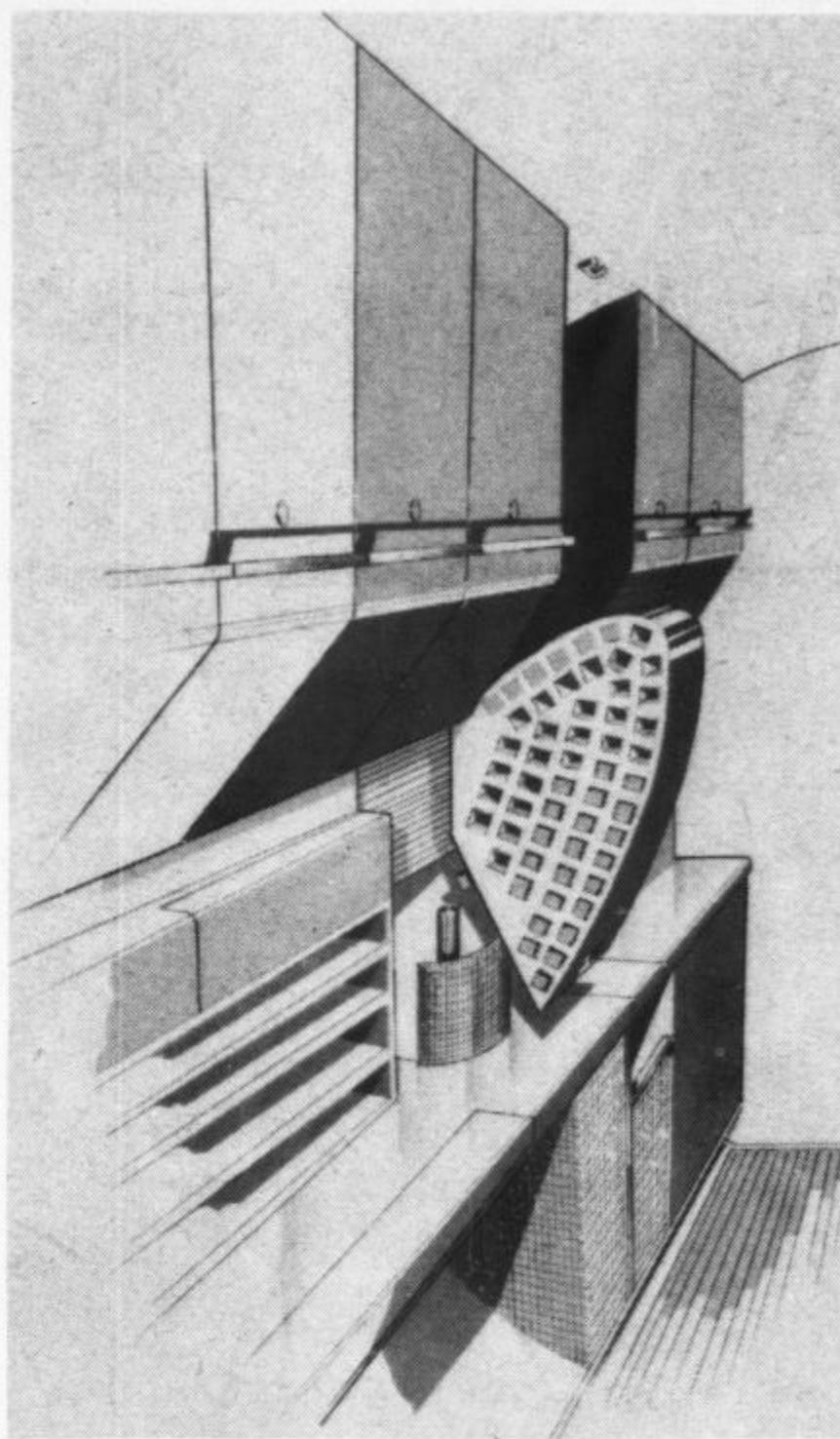
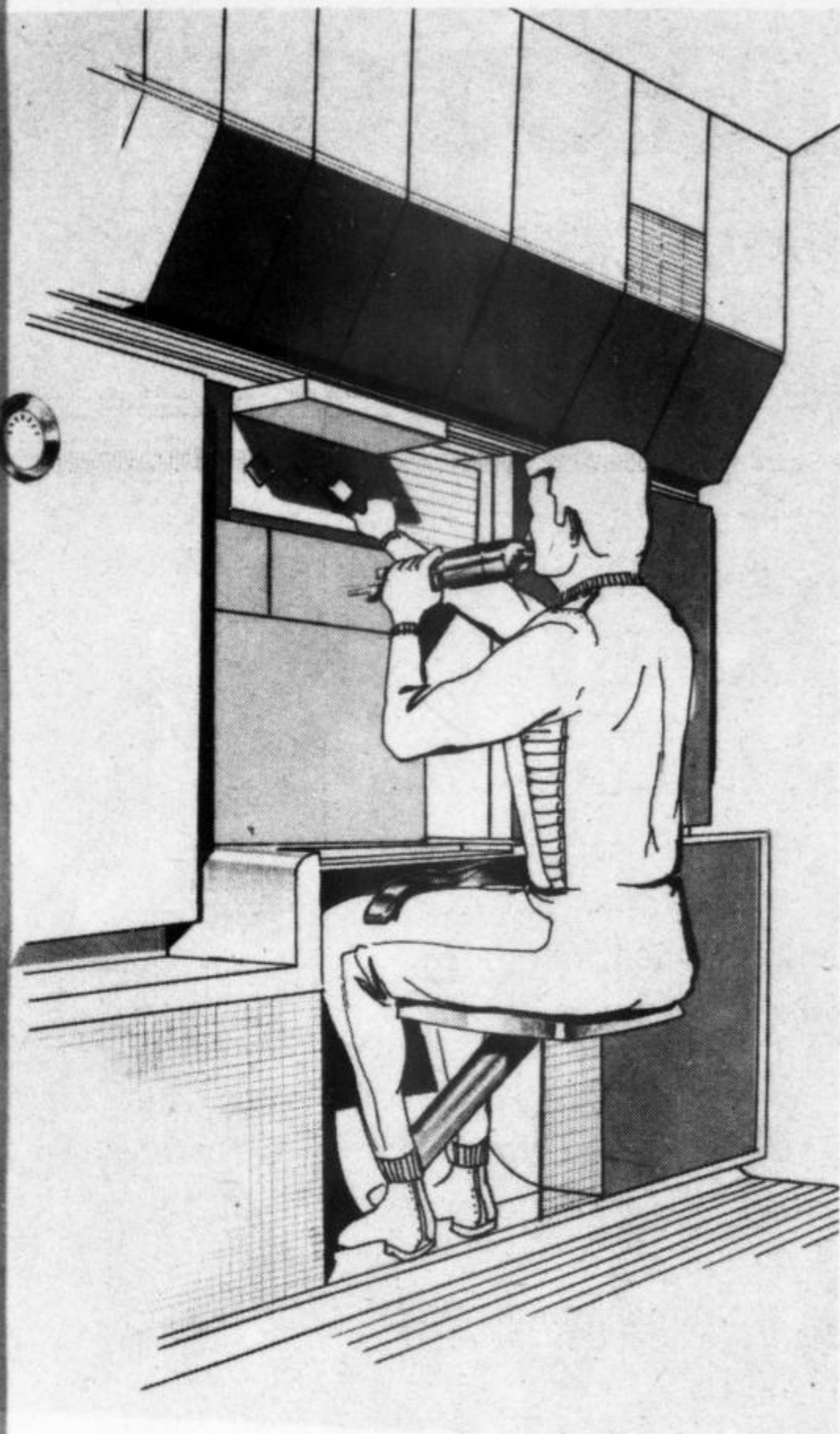
Since water does not behave at zero gravity as it does under normal circumstances, dehydrated items could present a preparation problem. However, Brehm says that this has been solved by designing a manually operated pressure pump within an air-free water system. To operate this device, which meters out a pre-selected amount of non-bubbly cold water, the space crewman will pump the handle with one hand while holding on to a support bar with the other.

Without something to grasp as anchorage, the weightless spaceman would push himself across the kitchen every time he tried to move the handle. If hot water is needed, three pints of 185-degree water produced by the built-in heater can be drawn every two hours.



ENGINEERING CONFERENCE. Team of technicians and human engineering specialists examine blueprints of the new space kit-

chen at USAF's Wright Air Development Division. Howard E. Brehm, right, is the project coordinator for the Whirlpool Corp.



MEAL TIME IN SPACE. Only one astronaut will eat at a time. After he has selected his food from the freezer and overhead storage cabinets (center), he will seat himself on a stool with knee clamps (left) that will keep him from floating in the cabin. Water transfer tank, right, is equipped with manually-operated pump. It will be used to carry regenerated water into the kitchen's hot and cold water tanks.

In the case of canned foods, the astronaut will fix a mouthpiece on each container, which is then placed in a device resembling a squeeze-type potato masher. By squeezing this attachment, food will be forced out of the container and into the astronaut's mouth. No squeezing devices will be needed for the more pliable tubes of food. Normal hand pressure will be sufficient as in squeezing out toothpaste.

While this process completely excludes traditional eating utensils, it will provide the mechanical means to keep the astronauts from starving in a pantry of plenty. Can-openers, forks and such eating tools are eliminated by this mechanized system.

Eating Technique

The step by step eating process being worked out by Brehm's engineers is as follows:

First, the containers, tubes or other packaged food items will be snapped into holders on a compartmented tray. The tray itself will be held down by clamps, and the astronaut will strap himself into a seat to keep from floating around. Now man and food can come together in a practiced series of operations. Choosing one tube or container at a time, the Space Kitchen's guest will place the mouthpiece between his teeth, squeeze out the food, and when he is finished, replace it with another item until he has completed his meal.

Following his meal the crewman will wash the mouth-

pieces with specially prepared antiseptic cloths. Dry and wet nutritive waste, which will be minimal, can be deposited in self-sealing disposal bins and sprayed with a bacterial-retarding solution.

Even in space, man will not escape KP duty, but the tasks will be minor, thanks to the automated efficiency of the system. Finishing KP chores, the astronaut returns to the flight deck. Only one crewman at a time will eat, as two men must always be at instrument duty stations during the entire 14-day mission.

In discussing the problems encountered so far in the Space Kitchen's development, Brehm says, "Most of the man-hours have gone into trying to design our way around the lack of gravity." He adds that a great deal of time would go into incorporating certain features of the kitchen that would not only provide convenience for the space crew but would also strike a note of familiarity.

"At apogee," he gives as an example, "the vehicle or capsule could be hundreds of miles from earth, bringing with it appalling 'homesickness'. Because the alien surroundings may psychologically upset the space pilots, we want the Space Kitchen to have some of the comforting features found in typical American kitchens. The sight of a familiar earthly object will be emotionally beneficial to the crew . . . even seeing cans shaped like those at home instead of functionally in some geometrical oddity will help." *(continued on page 46)*

MARS COLONY

INDEXED BY P.A.L.

Support of human life will be relatively simple on Mars

by **OTTO O. BINDER**

Mars, Venus and Mercury are the three celestial bodies, after the moon, most likely to be visited by man, but in what order is difficult to predict at present. Best guess: Mercury will be the last of the three and lack of knowledge about cloud-veiled Venus, in turn, will likely promote Mars into first place.

Many government agencies and space firms are already conducting serious feasibility studies, both as to transportation and eventual establishment of manned bases on Mars. These study programs are top-priority efforts, utilizing some of our best scientific talent.

One of the men working on the problem is Dandridge Cole. His feasibility studies on extraterrestrial bases go back several years, both at his former post with the Martin Company and in his present position with the Missile and Space Vehicle department of General Electric.

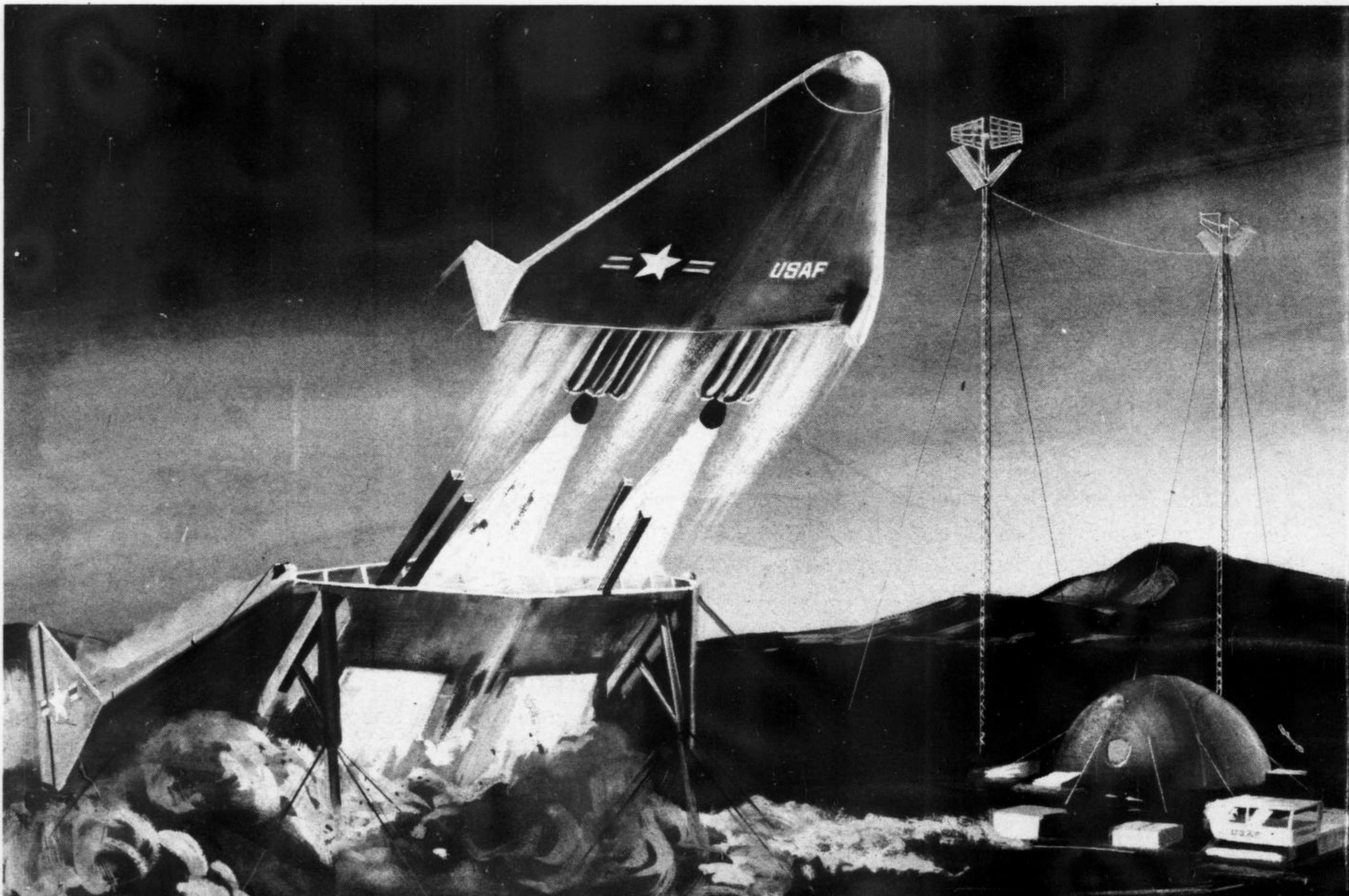
As a result of his research, Mr. Cole has come to believe that "Mars may eventually prove to be the most desirable place for man to live in the whole solar system—even superior to earth itself."

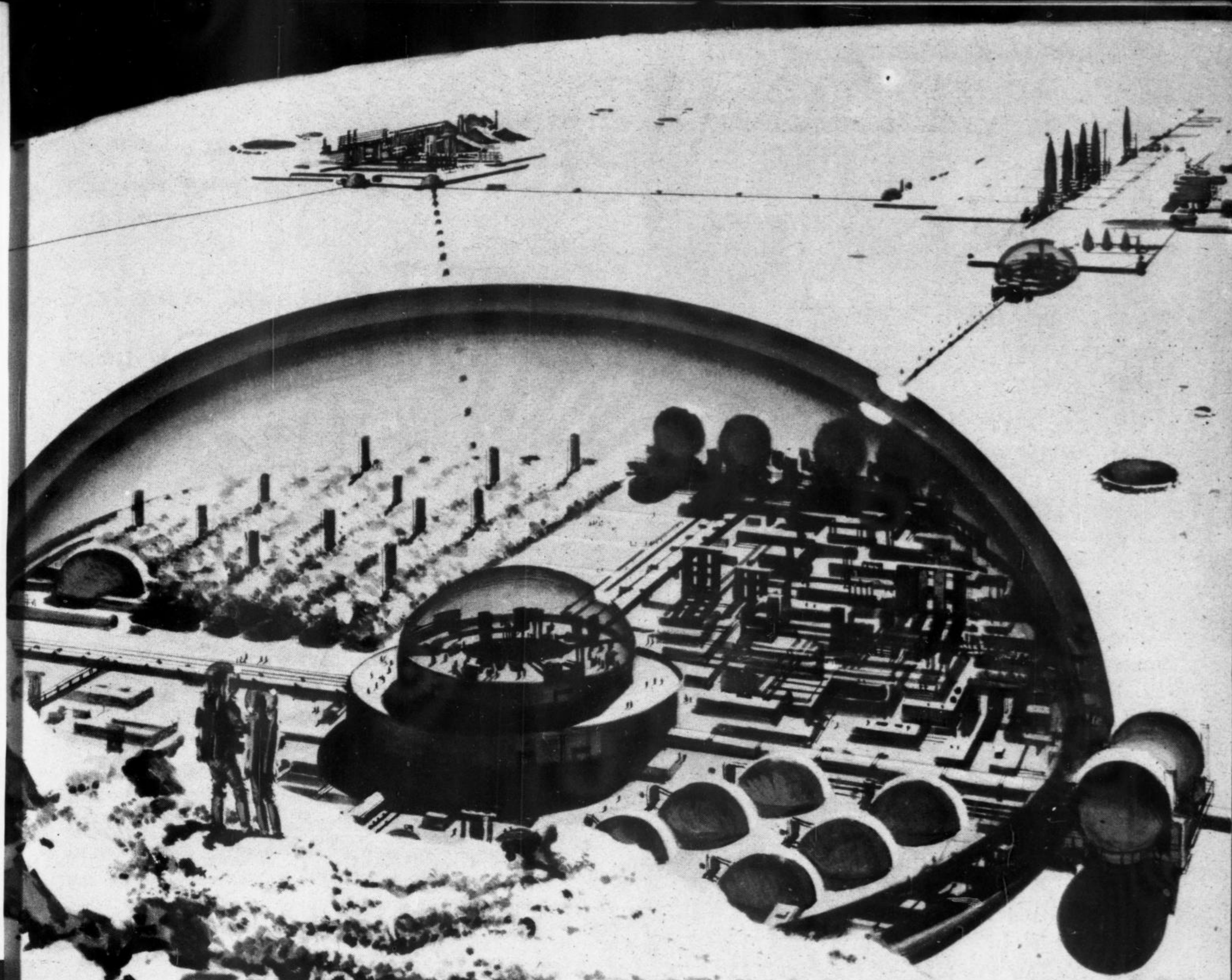
Although that prediction seems startling, it is backed up by several interesting possibilities:

(1) Colonists will find their labor made easy by the low Martian gravity—only 38 percent of earth's.

(2) Martian weather phenomena will seem extremely mild to our first settlers. They will find hardly any wind or rain and few, if any, of the hurricanes, floods, snow, lightning storms or other violent tantrums of the atmosphere familiar to us here on earth.

MARS TRANSPORTATION. Thin Martian atmosphere will support aerodynamic vehicles that will fly between bases.





PLASTIC DOME. Experts propose use of huge plastic bubbles to contain a breathable atmosphere for Mars colonies.

(3) Mars colonists need not fear disasters such as earthquakes or volcano eruptions because the small planet Mars, cooling before our earth ages ago, is now thought to be geologically stable.

(4) Having no high mountains to scale, Mars settlers will find travel easy across the low hills and flat deserts.

(5) There is probably no danger from hostile life forms, animal, vegetable or mineral.

The Prime Essentials

It is quite possible that settlers will have an easier time on Mars than the American pioneers had in hacking their way through forests and struggling across mountain barriers while beset by storms, wild beasts and savages.

However, that is only one side of the story. The other side is more foreboding. Three prime essentials of life for our human species are not readily available on Mars—food, water and breathable air. Of these, according to Mr. Cole, "The principal disadvantage is, of course, the

lack of sufficient oxygen in the atmosphere."

Though spectroscopic studies made by astronomers on earth are not considered conclusive, they do reveal certain basic facts about the Martian atmosphere. First, observers found it to be so thin that the sea-level pressure (using the earthly term for sealess Mars) rates about 1/10 that of earth. Without breathing helmets, visitors to Mars would gasp as if at a height of 12 miles and quickly expire. Also, they would have to wear some type of pressure suit to protect their bodies. The relatively simple high altitude suits worn by jet pilots on earth would serve adequately to keep men on Mars from "bursting".

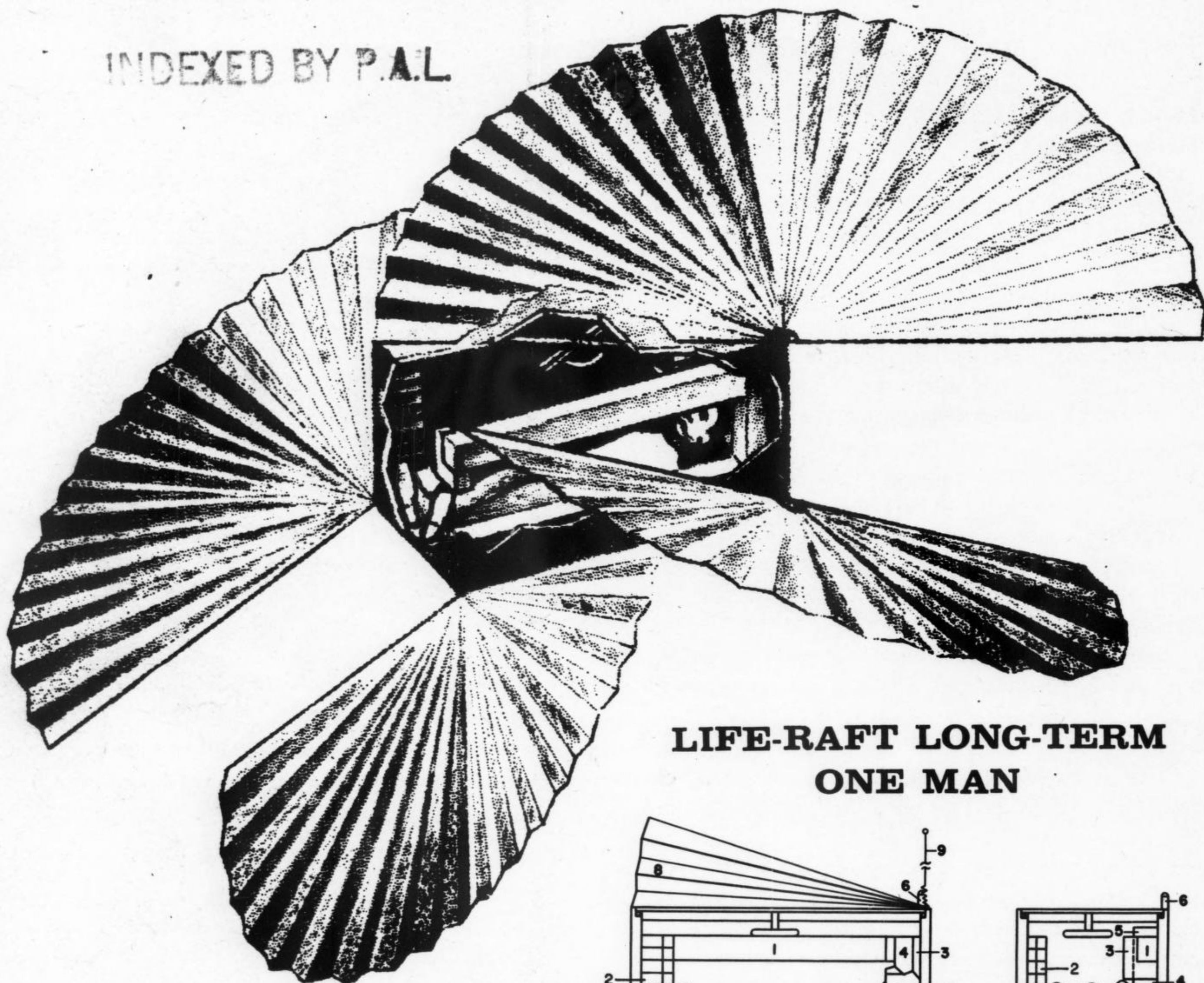
At Home on Mars

Martian air, say the experts, is composed mainly of nitrogen and inert gases like argon, with some traces of carbon dioxide and water vapor. The lack of free oxygen, which observers have not positively detected in the Martian atmosphere, can be overcome, maintains Cole,

(continued on page 57)

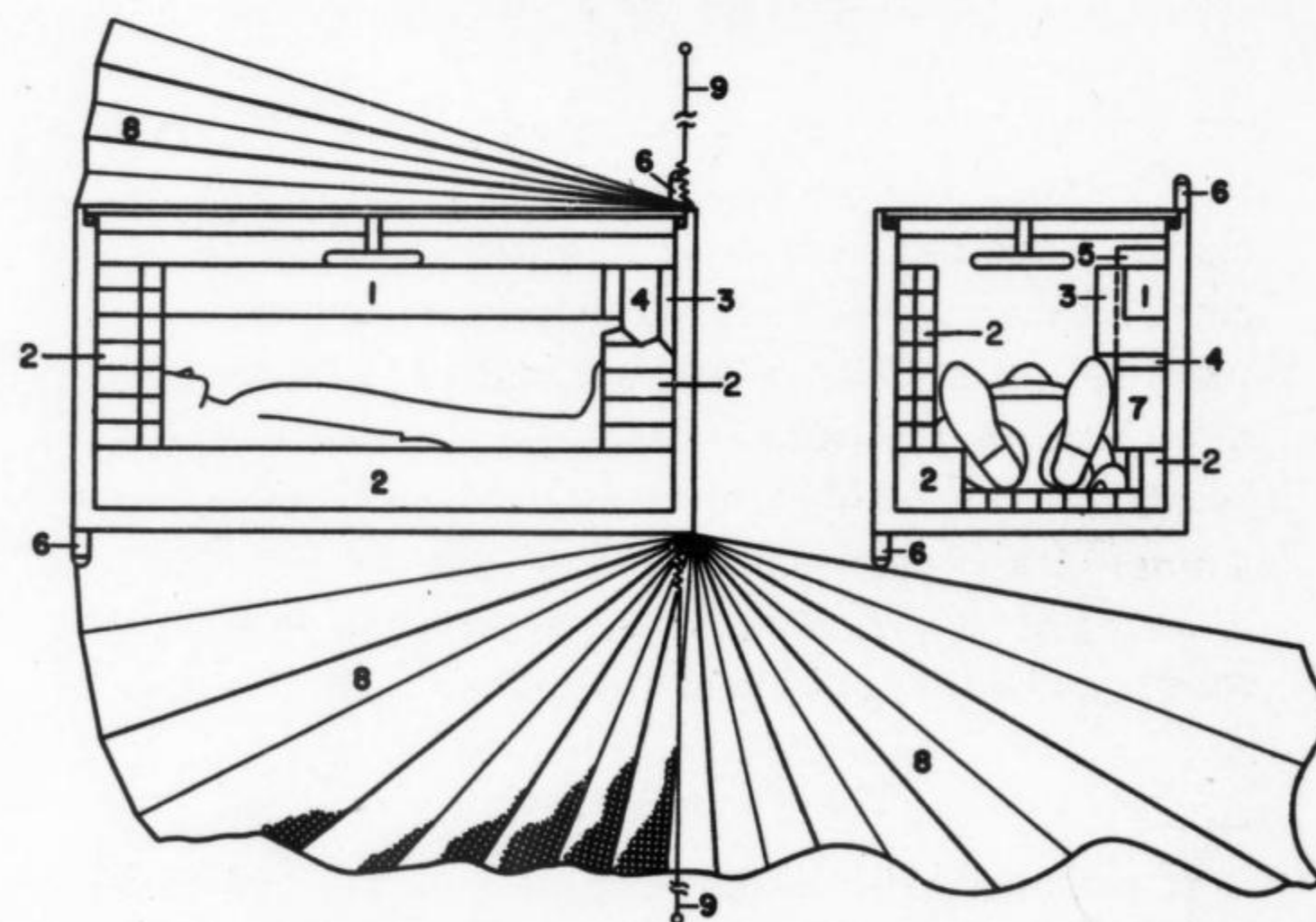
THE PROBLEM OF S

INDEXED BY P.A.L.



LIFE-RAFT LONG-TERM ONE MAN

Component		Weight in Pounds	
		Near Mars	Near Venus
Structure		150	150
Insulation		25	25
Oxygen			
Water			
Atmosphere	Regenerating		
Purification	System	200	200
Food		365	365
Solar Cells		64	12
Auxiliary Solar Cell Structure		100	15
Signal Generator, Antenna, Timer		16	16
Storage Batteries		8	4
		928	787



1. CONTAMINATED AIR REGENERATOR
2. FOOD
3. SIGNAL GENERATOR AND TIMER
4. BATTERY
5. FAN
6. LIGHT
7. H₂O GENERATOR AND STORAGE
8. SOLAR CELL ARRAY
9. ANTENNAS
10. WASTE REGENERATOR

F SURVIVAL

Unique life-rafts will be used for space emergencies

by **HAROLD BLOOM**, G.E. Project Director,
with **TED STOIL**

"Abandon ship!"

As long as men have sailed the seas of earth and flown in its skies, they have faced the problem of ultimate emergency, when—through mechanical failure or natural disaster—ships and planes were about to meet destruction. To save themselves, they have devised life-rafts and life-boats, parachutes, survival kits and an arsenal of other paraphernalia to preserve life while they awaited rescue or made for safety.

But what of spacecraft wrecks? The hazards astronauts aboard will face are manifold, and provision must be made for escape and survival in space. Thorough as our technical know-how may be, it is impossible to prevent the eventuality—hopefully rare—that some space vessel will one day ring with the alarm: "Abandon ship!"

Certain sources of possible disaster in space can easily be foreseen, and prevented. As ships are designed with watertight bulkheads, so spacecraft will be divided into "cells," which can be separately sealed off. Thus, for example, if a small meteor should puncture the outer hull of a spaceship, the crew could still be protected by closing off the damaged area.

On the other hand, astronauts would certainly have to abandon ship in certain major emergencies, including mid-course propulsion failure; bursting of tankage containing highly reactive fuels; breakdown of nuclear power controls; loss of retro-rockets for re-entry; and contamination of air or water supply.

Oddly enough, in such cases, space crews will face problems more closely akin to those of shipwrecked sailors, than of parachuting fliers. The latter, bailing out over land, are usually exposed to an "unfriendly" environment only until they reach the ground. Even in the rarity of jungle, arctic or desert bailouts, they often can reach safety or be rescued in a relatively short time.

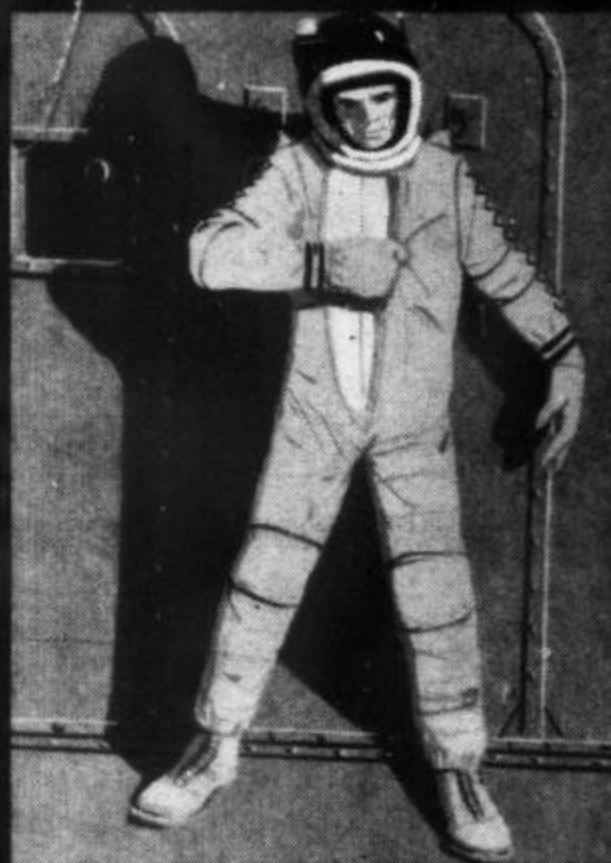
In space, however, as at sea, shipwrecked crews will face long exposure to an "unfriendly" environment, often with low chance of outside rescue. For this reason,

survival equipment for astronauts must provide reliable protection against the life-snuffing threat of space.

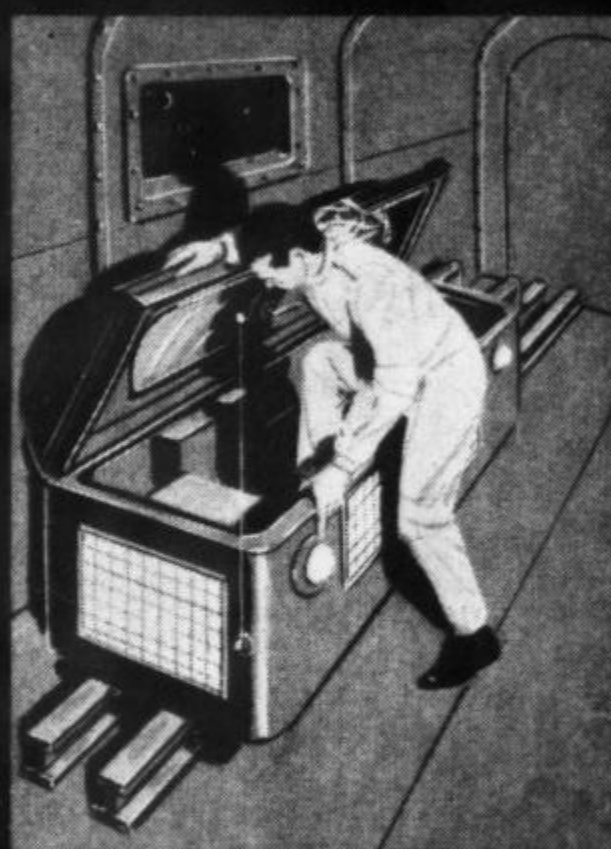
Sailors abandoning ship often have minimum survival gear—in extreme emergencies only the clothing they happen to be wearing. But the astronaut facing the more deadly realm of space must at all times wear some basic form of spacesuit to seal in his body temperature and pressure if he should be forced to "drift" in the nothingness surrounding his abandoned craft.

(Continued on next page)

PREPARE TO ABANDON SHIP

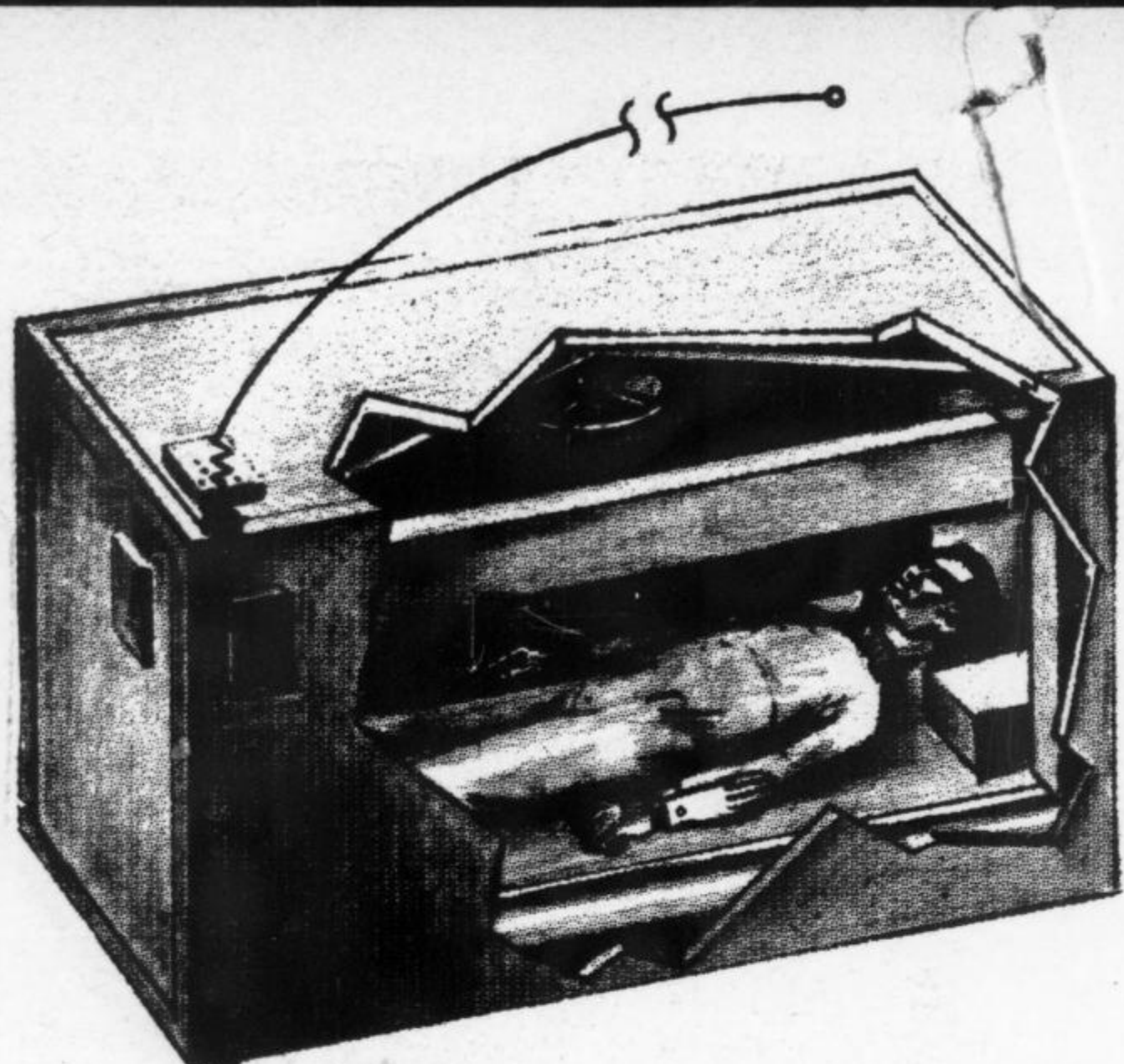


LAUNCH LIFE RAFTS



ABANDON SHIP

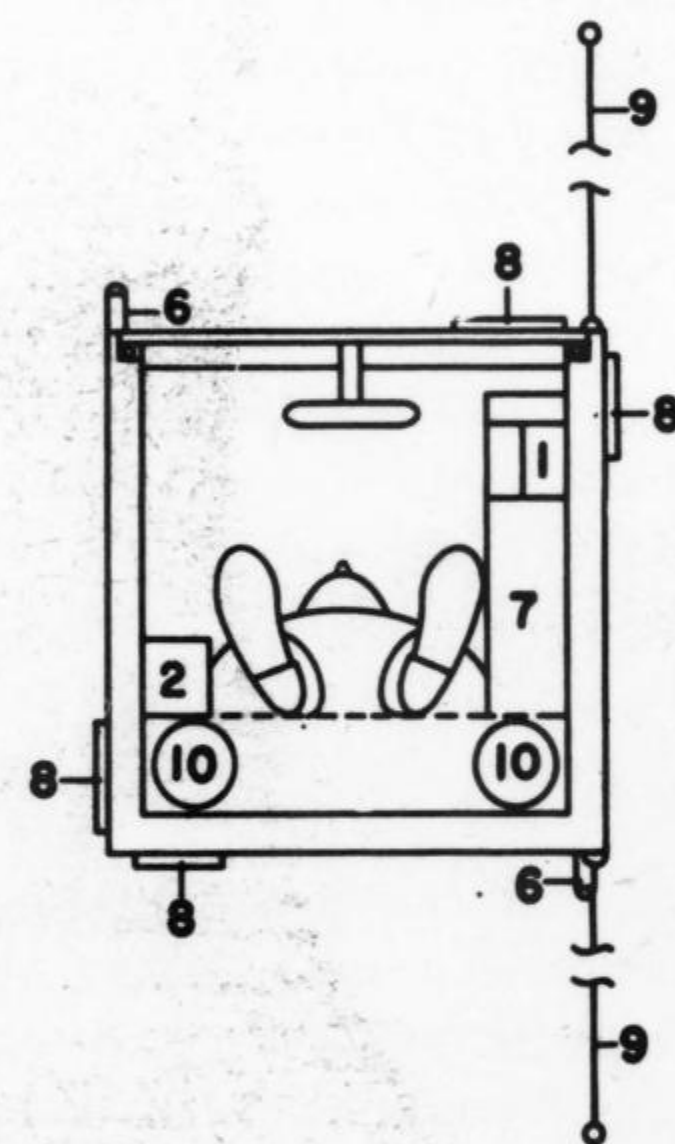
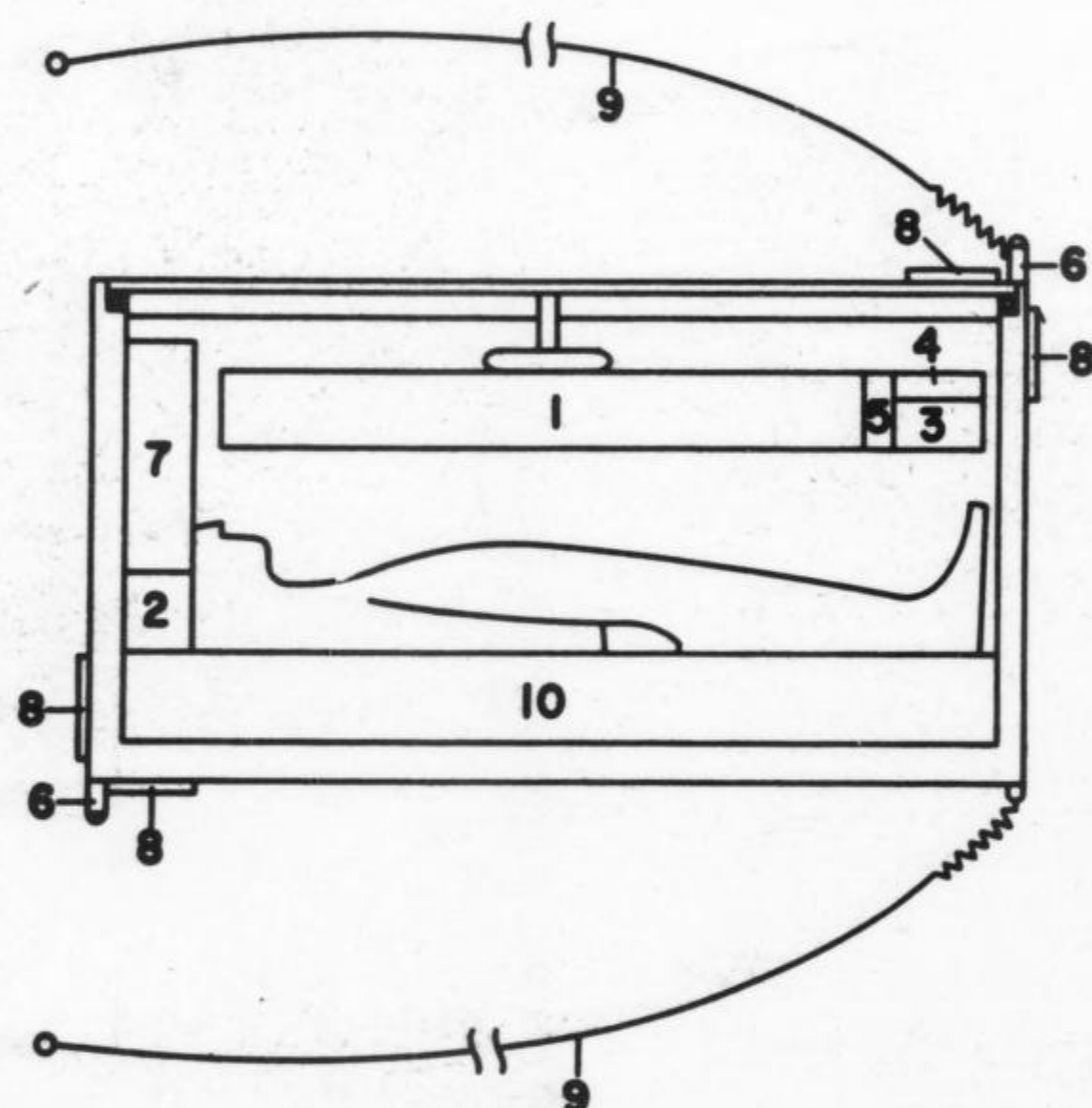




LIFE-RAFT SHORT-TERM ONE MAN

Component	Weight in Pounds
Structure	150
Insulation	25
Oxygen (with storage container and metering)	9
Water	22
Atmosphere Purification	10
Food	4
Signal Generator, Antenna, Batteries	15
Solar Cells, Mounting Frame, Wiring	5
	240

1. AIR PURIFICATION
2. FOOD
3. SIGNAL GENERATOR
4. BATTERY
5. FAN
6. LIGHT
7. H₂O SUPPLY
8. SOLAR CELL ARRAY
9. ANTENNA
10. OXYGEN SUPPLY



This suit is his "life-preserver" or *minimum* survival equipment. Like the swimming sailor, the spaceman in this situation can remain alive for only a short time—until his breath and warmth give out. He also has no means of controlling his speed or direction, except by using a reaction pistol with a limited power supply. Finally, he has few means of alerting rescuers. "May-day" signals from his helmet-radio would have short range. And, if rescue does not come quickly, the floating spaceman—like the swimming sailor—must die.

In less drastic cases, when there is sufficient advance warning, the sailor at sea can don a life-jacket before jumping overboard. This extends the time he can spend in the "unfriendly" ocean environment. Whistles and signal lights attached to the life-vest can even guide rescuers.

Similarly, the spaceman's "life-jacket" will be a device he can put on and seal tight before he abandons ship. It might be simply a heavy-duty spacesuit, or a one-man capsule, of the type astronauts will probably

use for working on the outside of a space vessel or on airless planets. It would contain a walkie-talkie type radio, temperature controls and an oxygen supply.

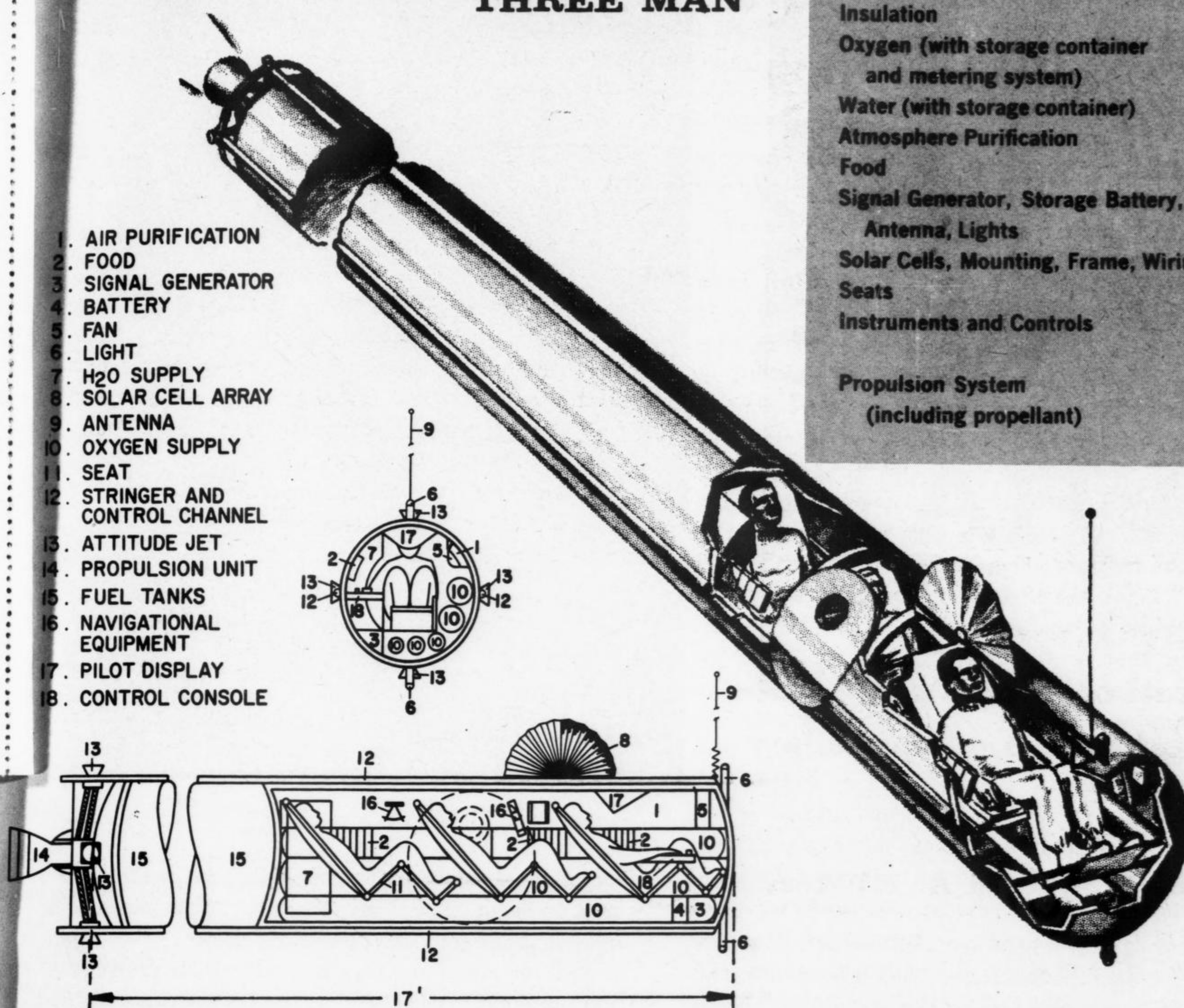
But the maximum possible operating life of such a device would still be quite limited, giving the lost astronaut only a few hours of survival. Something more elaborate is obviously needed, and we at General Electric have been devoting extensive research to this end.

Our basic emphasis, of course, has been on survival rather than comfort. This, in turn, automatically dictates the design requirements: minimum weight and maximum functional life support, to bridge the time between abandoning ship and being rescued or reaching safety.

How long would that time be? It would depend on the spaceship's mission. On an aborted moon trip, for example, pickup by other craft might be achieved in less than four days. But failure on a Mars or Venus flight could mean up to a long year's wait before rescue.

We have calculated these waiting periods for space-

LIFE-BOAT SHORT-TERM THREE MAN



Component	Weight in Pounds
Structure	191
Insulation	33
Oxygen (with storage container and metering system)	25
Water (with storage container)	66
Atmosphere Purification	30
Food	12
Signal Generator, Storage Battery, Antenna, Lights	15
Solar Cells, Mounting, Frame, Wiring	5
Seats	30
Instruments and Controls	150
	557
Propulsion System (including propellant)	2,853

wrecked astronauts at maximum, to provide a safety margin in designing our "space life-craft" and to allow for delays in achieving the best rescue-rendezvous factors. Actually, rescue ships could reach the moon in about two days; Mars or its orbit in eight to nine months, and Venus or its orbit in less than five months.

These extremes in potential rescue time have led us to plan two separate types of space life-craft—the one-man "life-raft" and 3-man "life-boat", each of which has a "short-term" and "long-term" capability.

The one-man space life-raft, designed for four days' use by a spaceman abandoning ship in cis-lunar regions, will be the simplest and lightest type of survival equipment. It will also be, obviously, the type included in early manned flights.

Such a short-term space-raft can, in fact, be constructed with equipment now available. Our GE concept is a chest-like container holding the astronaut, fitted with air and water systems, food rations, solar energy converters, storage batteries and a signal gen-

erator. With its lid open, during normal operations of the space vehicle, this chest can serve as a sleeping-bunk for the spaceman. In an emergency, he leaps into the life-chest, pulls the lid shut and dogs the latch. This automatically starts the ecological life-support cycle going, plus "Mayday" broadcasting, while the life-chest is being forcibly ejected from the spaceship.

This short-term space life-raft is good only for orbital or lunar abandon-ship emergencies, and will keep him alive for four days until rescue comes.

In timer insulation will consist of light blocks of plastic foam, which the astronaut can shift manually from the hot and cold sides of his capsule as required by his temperature needs. A fairly simple automation system will provide fresh oxygen and purification of air and water. The electrical output of the solar power cells will supply enough power for transmitting distress signals over the distance between earth and the moon. In addition, auxiliary storage batteries will make up for lost solar

(continued on page 60)

acid to provide average thrust and impulse. Their thrust level would subject occupants of the space-boat to short-period accelerations of about 10 g, whose stress would be taken up through seats made of nylon sheeting on aluminum frames. Propulsion would be supplemented by hot-gas attitude jets, fired by a pilot at a control console monitored by navigational instruments. The short-term (4-day) unit will carry minimum fuel to negotiate only from moon to earth.

The long-term, three-man version of these self-propelled survival units would again have to be designed in two models — for Mars or Venus flights. Besides the previously men-

the Venusnauts sent to radar-map the surface of that mystery planet.

In either case, however, the size and weight of these life-boats would enormously complicate launching problems if they were to be carried within the mother-ship. An obvious solution would be to place the space-boats in earth-orbit separately. They could then be picked up by Mars or Venus-bound spaceships and towed or carried pickaback en route.

Until now we have considered only life-craft that would take up orbit upon reaching earth and stay in space. There remains the possibility of a crew actually returning to earth a-

as compared to orbital descent at 17,500 mph.

Such craft will have to be equipped with sensitive guidance systems, controllable to within a single degree, as well as parachutes or other drag equipment to slow descent, and signaling devices to summon rescue parties on the ground or at sea. Nevertheless, even such a complex earth-fall capsule could be built to weigh less than 1,000 pounds per man-unit.

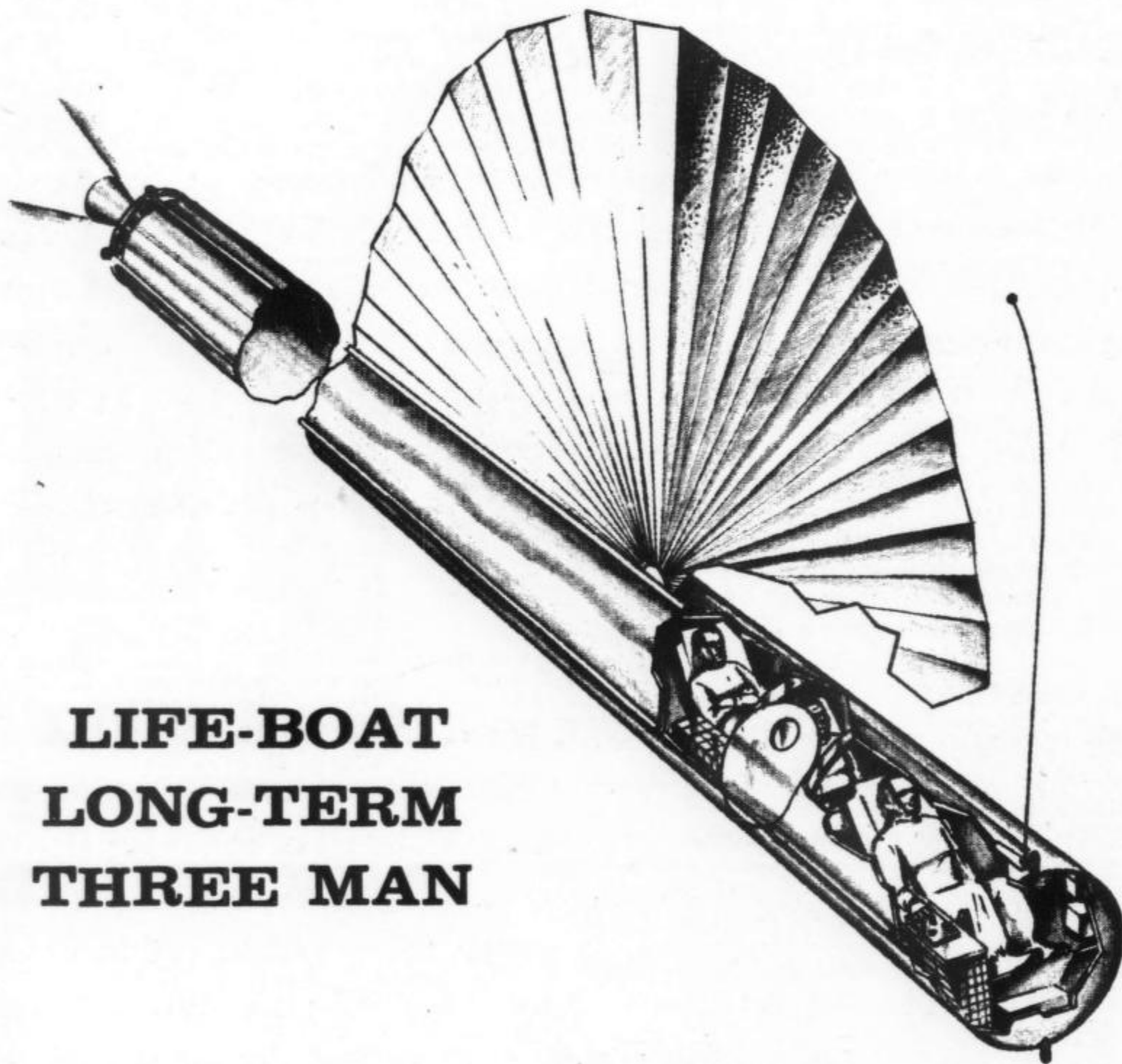
Our preliminary studies show that we can even today build at least the basic survival units. Human factors, of course, are less fathomable. We still must devote a great deal of research to weightlessness, prolonged confinement, anxiety in isolation, and other survival problems which will face the spacewrecked astronaut.

So far, space-medicine tests in these areas are not conclusive. They show that a confined, isolated man can survive for a week with slight discomfort and little mental anguish. But the test subjects have all known that their condition was being monitored by other humans close by, with the power to "rescue" him at any time.

But what about a year's wait for a man in a "space-raft"—actually marooned in the blackness of the outer regions? Is two-way communication the answer? Tranquilizing drugs? Space-medicine experts cannot yet say.

What we do know is that the actual hardware for escape from a rocket-ship wreck is within our reach today. Survival techniques, plus coordinated rescue operations, can prevent space castaways from facing the unthinkable ordeals of an interplanetary Robinson Crusoe. ■ ■

LIFE-BOAT LONG-TERM THREE MAN



tioned variation in solar-cell weight for communications power, we must also consider the difference in fuel requirements for minimum energy transfer to earth's orbit.

The characteristic velocities of these transfers are 1,170 ft./sec. less from Venus than from Mars. Thus, the astronauts who become spacewrecked while observing the Martian canals will need a heavier life-boat—with more fuel and solar cells—than

board their emergency vessel. Another variation is their escape from an earth satellite—instead of a spaceship.

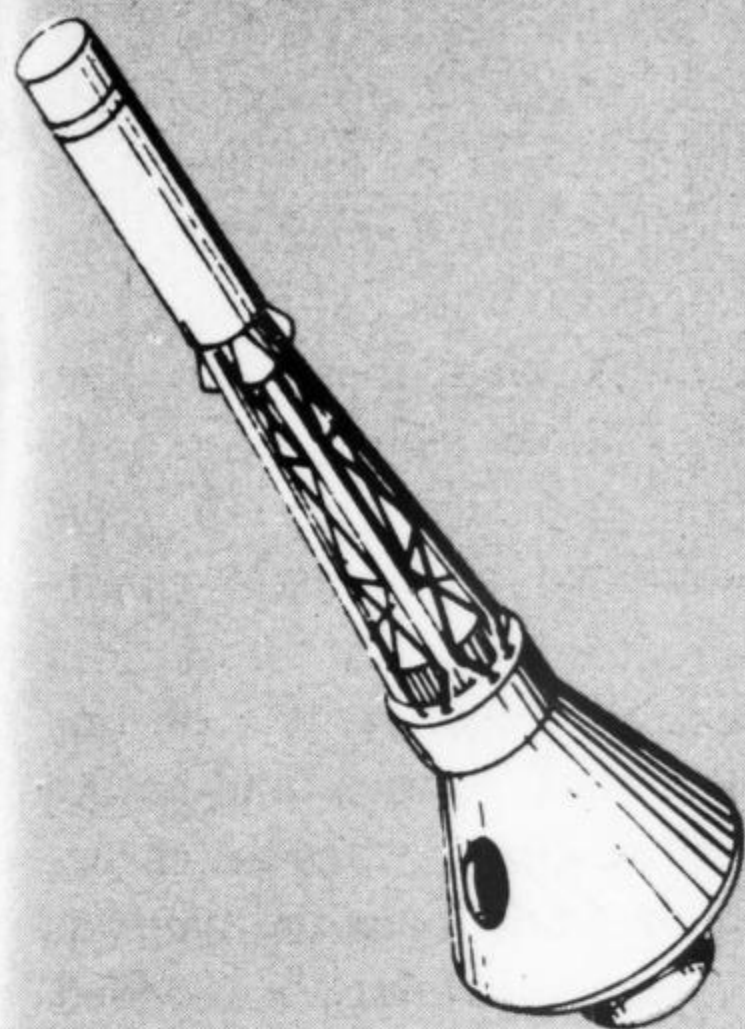
These would be more difficult operations, involving the problems of insulating the men from intense re-entry heating and protecting them against the g-strain decelerative pressures of atmospheric descent. It would mean a completely new structural design, especially for vehicles returning at escape velocities (about 25,000 mph).

Credits:

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SPACE
VEHICLE
NO. 2

ATLAS



HALF-STAGE BOOSTER. With the forthcoming manned Mercury orbital flight, the Atlas will become America's most famous booster. The Atlas, our only operational ICBM, has been chosen to take our first astronaut into space because of a formidable reliability record. This performance is due to several unique concepts that have been incorporated into the Atlas. The half-stage configuration, for example, allows all three engines to fire at launching, thus avoiding any second-stage ignition failure. The half-stage is a twin-engine booster sleeved around the central sustainer engine. After the auxiliary boosters burn out, their sleeve detaches and the single sustainer engine drives the Atlas to its required velocity. Gimballed vernier rockets, controlled by an inertial-guidance system, stabilize the missile's flight and trim its velocity to the required trajectory. Convair engineers, who built the Atlas, are confident their booster is ready to meet its most historic test—and hurl the first living American into a 300-mile high orbital path above the earth.

PAYLOAD

(MERCURY CAPSULE)

Weight 1 ton
Mission Manned orbital flight

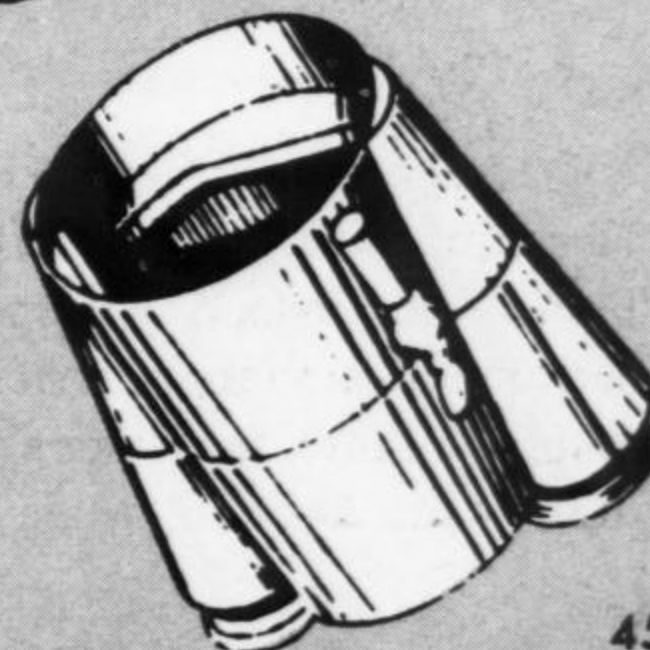
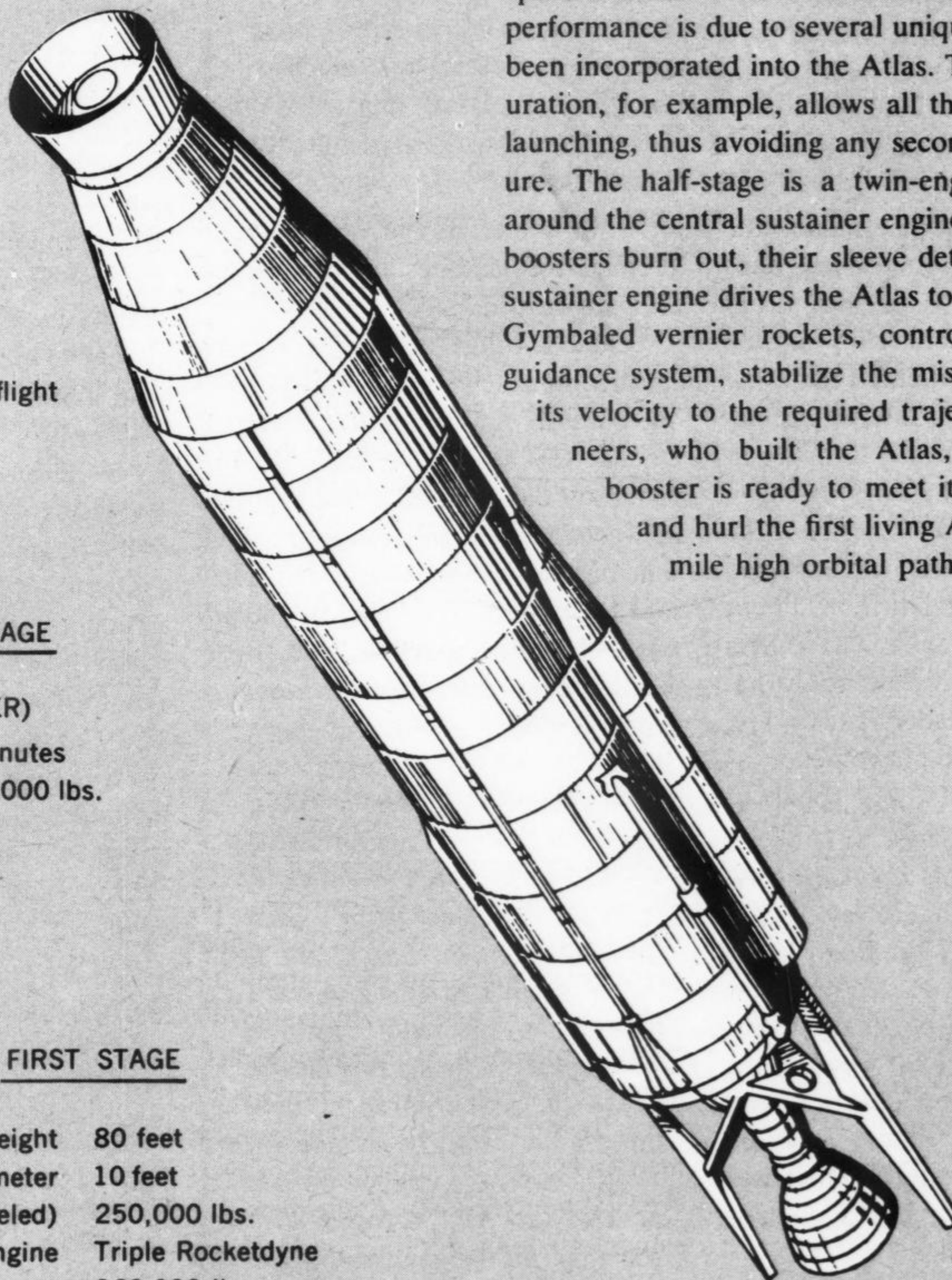
SECOND STAGE

(SUSTAINER)

Burn time 5 minutes
Thrust 120,000 lbs.

FIRST STAGE

Height 80 feet
Diameter 10 feet
Weight (fueled) 250,000 lbs.
Engine Triple Rocketdyne
Thrust 360,000 lbs.
Burn time 2 minutes
Guidance ground controlled inertial



SEPT. 50c
VOL. 1, NO. 10

SPACE WORLD

The Magazine of Space News

NEXT STEP: MANNED
ORBITAL FLIGHT

Dandridge Cole

Isaac Asimov

Eilene Galloway

Willy Ley

A Noted Russian Astronomer Reports:
THERE IS INTELLIGENT LIFE ON MARS!

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SPACE WORLD

The magazine of space news • September 1961

CONTENTS

- 12 SATELLITES FOR PEACE...OR WAR?, by Eilene Galloway**
Some life and death implications of space science are examined.
- 16 MACRO-LIFE, by Dandridge Cole**
Our expanding technology and its effects upon the ultimate society.
- 20 THERE IS INTELLIGENT LIFE ON MARS, by F. Zigel**
A Russian astronomer makes new observations on an old controversy.
- 22 GUIDANCE ENGINEER, by John Rublowsky**
An interview with Willis Wing, a leading authority in this field.
- 25 ALL ABOUT METEORS, by Willy Ley**
The fascinating subject of meteors made simple to understand.
- 28 RECOVERABLE BOOSTERS, by Otto O. Binder**
Multiple-use launch vehicles will reduce our space costs sharply.
- 32 THREE STEPS TO THE MOON, by Roy Brereton**
Moon and earth orbiting stations as steps towards Lunar conquest.
- 37 WOMEN ASTRONAUTS, by Donald Cox**
Women will play an increasingly important role in space flight.
- 38 PICTURE NEWS**
A photographic report on this month's developments in space.
- 40 MEASURING RODS IN SPACE, by Isaac Asimov**
A detailed view of yardsticks used by present-day cosmologists.

DEPARTMENTS

- | | | |
|--------------------------|-----------|-----------------------------------|
| NAMES IN THE NEWS | 5 | 36 WHAT'S NEW |
| ORBITING AROUND | 6 | 43 SPACE VEHICLE #4: TITAN |
| QUESTION BOX | 8 | 45 RUSSIAN REPORT |
| BOOK REVIEWS | 24 | 47 SPACE QUIZ |

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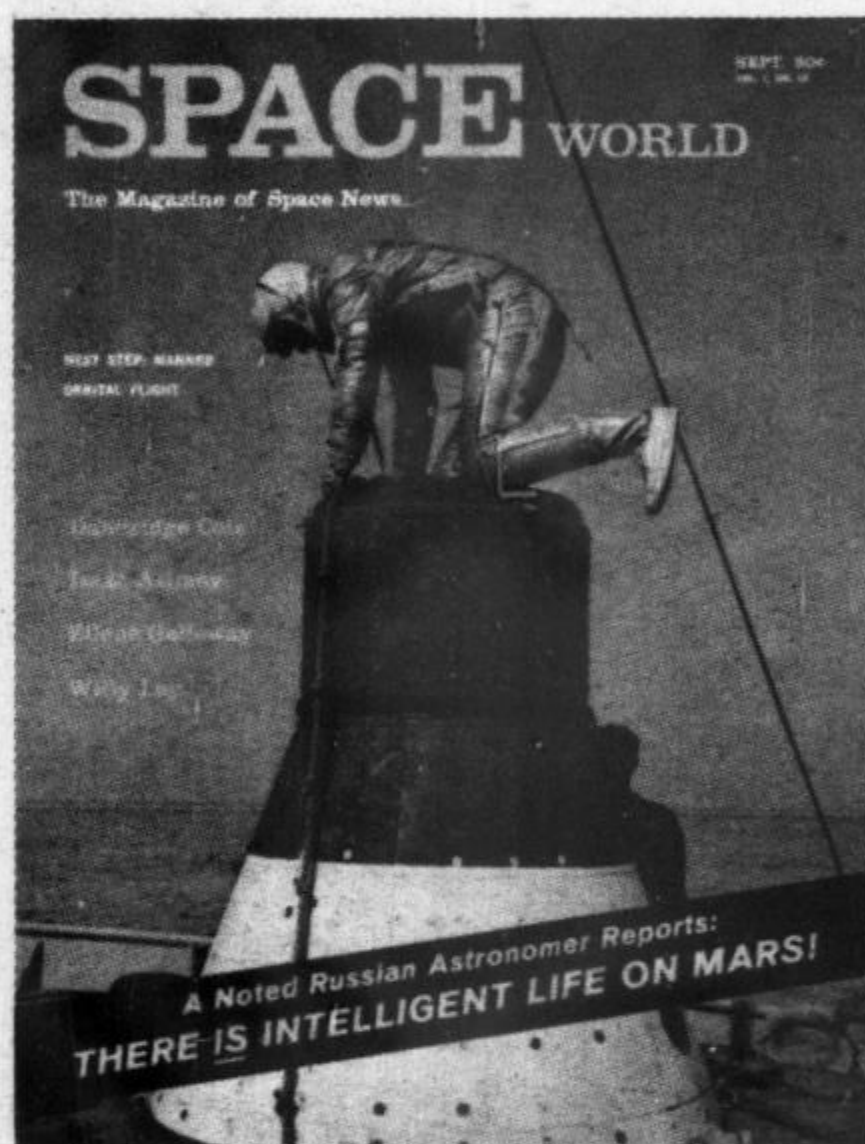
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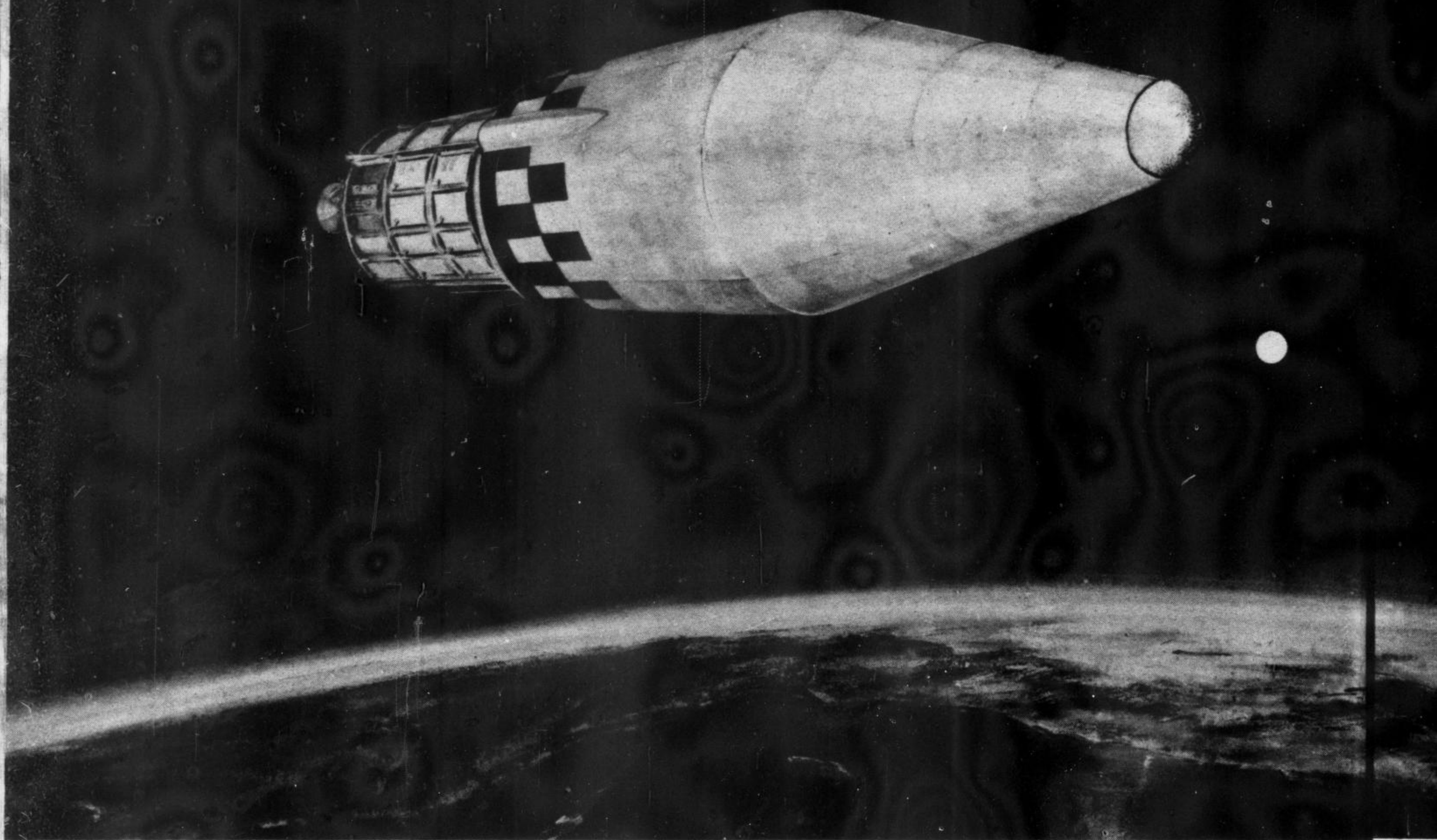
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On the cover: An astronaut emerges from the Mercury Capsule in trial run for new manned sub-orbital flights that will follow Alan Shepard's epochal first shot into space.



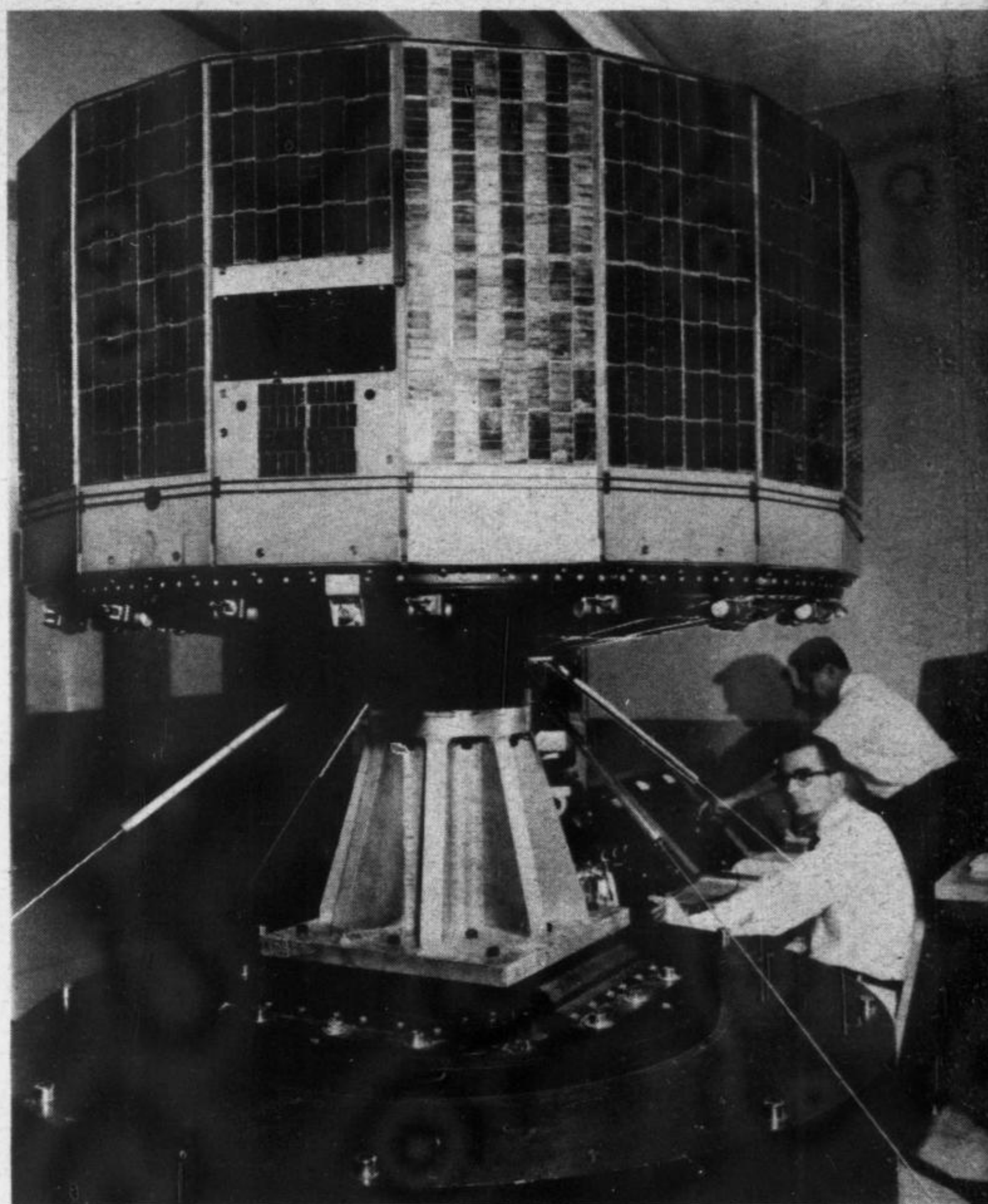
INDEXED BY P.A.L.

SATELLITES for peace -or war?

Our international cooperation in

Space exploration is generating forces that can be used to strengthen conditions required for a durable peace. For some years now, the peace of the world has rested upon what has come to be called "the balance of terror" of thermonuclear weapons. In the age-old pattern of using both rewards and punishments as incentives to control human behavior, we have necessarily had to rely on protecting such peaceful conditions as we now enjoy by providing for retaliation against aggression. At the same time, and indeed ever since the United States first had a monopoly of the atomic bomb, we have been seeking effective ways of achieving international peace by the control of armaments.

Armament and disarmament are two sides of the same coin which is designed to buy peace. Just as religious concepts are used to keep man on the right path by promising Heaven and threatening Hell, so in the



Peaceful Purposes. Discoverer satellite, left, and Tiros weather reconnaissance satellite, above, are two examples of space efforts whose scientific value fosters international cooperation.

in space can be a strong force for peace

by EILENE GALLOWAY

field of international political affairs both approaches have been used to prevent war and ensure peace.

The advances made in weapons technology and the difficulties experienced in reducing international tensions have made it difficult to find methods for building a foundation of mutual trust among all the nations of the world.

Now that scientific and technological talents are being applied to the space environment, we have been given not only tools for exploring the universe, but also a variety of new ways of working for peace.

What is meant by world peace? In what ways can satellites and space vehicles contribute toward this objective?

World peace is a dynamic international order in which nations have common objectives. In such a world order nations (1) recognize that conflicts of interest may

arise, (2) provide for the settlement of disputes by peaceful rather than violent means, and (3) develop methods of cooperation which will tend to bring about harmony rather than discord.

Too often world peace has been thought of as a passive state resulting from the mere lack of military aggression. Such a limited concept can yield only limited results. To achieve the maximum in world peace, we must work in specific areas to establish patterns of cooperation which can be expanded toward the larger goal of the rational and orderly conduct of international relations.

The advent of the space age offers new opportunities for advancing toward this objective.

As satellites operate in global orbits which disregard the boundary lines of nation states, they dictate certain requirements for international cooperation. A worldwide network of ground observing stations is essential to track
(continued on next page)

Space science has revolutionized the methods of war

space probes and satellites whether by optical methods, radio or radar. The network must be made by pre-arrangement and design because no nation encompasses within its own boundaries the range of latitude and longitude necessary for adequate tracking.

The limitation of the radio spectrum is a scientific fact which necessitates agreement between nations on practicable methods for allocating frequencies. The alternative could be such chaos in communications that both terrestrial radio transmissions and those from outer space would be affected by interference.

The reentry of space vehicles into the atmosphere and their landing on earth will create problems which can only be met by international agreement based upon a common understanding of the ways in which such situations are to be handled.

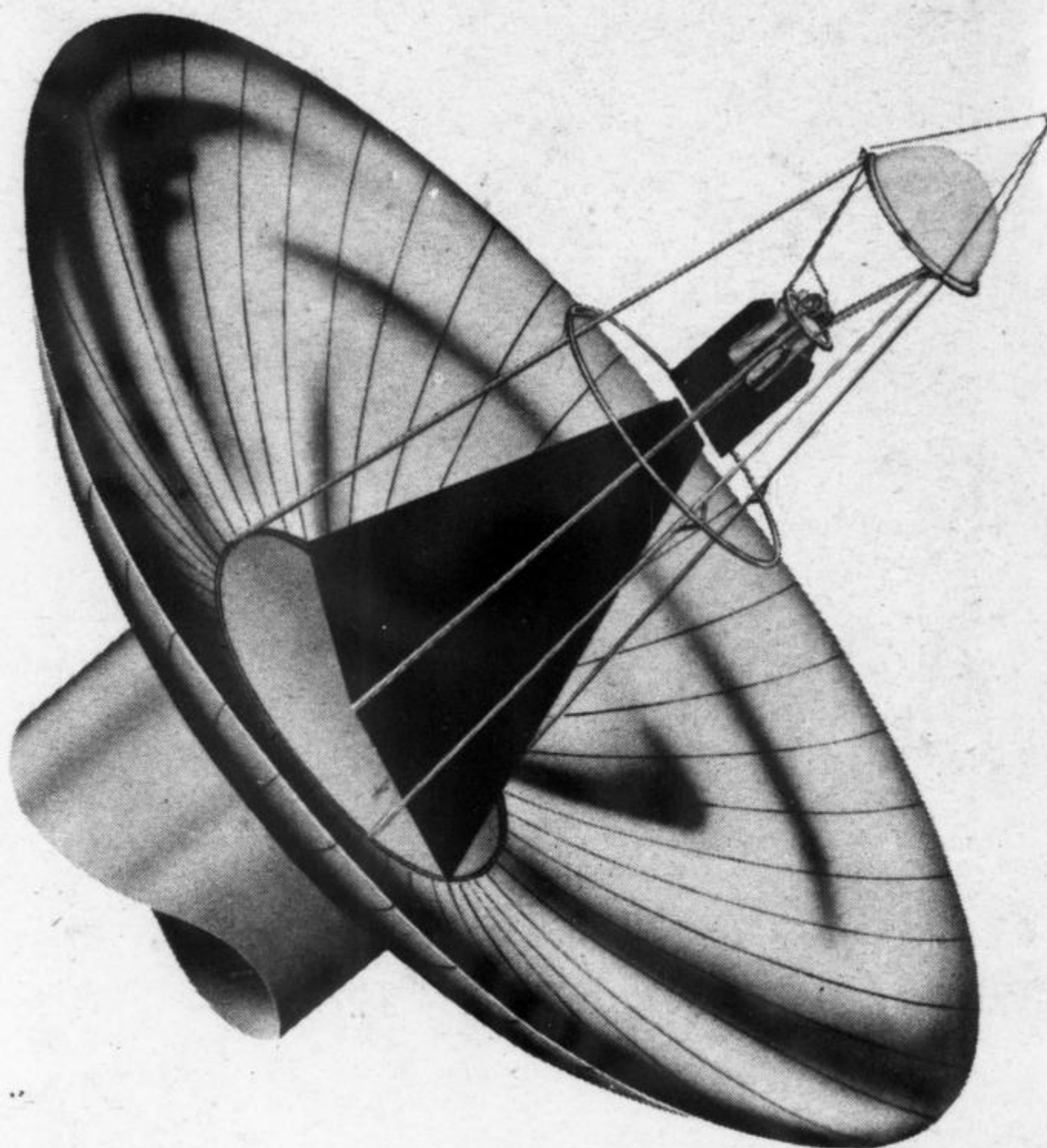
The determination of liability for damage or injury resulting from space craft, the identification and registration of vehicles, and the scientific need for preventing contamination of celestial bodies — all such problems point up the need for nations to cohere in devising solutions which are mutually satisfactory.

Space exploration requires additional factors which can be used to develop patterns of international cooperation. While they are not in the same category as the problems which have been mentioned as susceptible of solution only in terms of international negotiation, they illustrate the inherently worldwide scope of space activities.

Scientific talent and resources are available in many nations and are by no means the monopoly of a few. Scientists and engineers can engage in basic and applied research to extend the knowledge of cosmic space regardless of their nationality. They can build the instruments required for satellites even though the nations of which they are citizens do not have the resources to build expensive launching equipment. Cooperation can be fostered by international launchings, joint research projects, and the exchange of scientific personnel and information.

The practical uses of the results of space research and development are by their very nature of interest to the inhabitants of the entire globe. Improvements can be anticipated in weather forecasting and radio communications, in navigation and the mapping of the earth. It is conceivable that the potential of satellites in detecting impending hostilities might act as a deterrent to surprise attacks. These are but a few of the expected advances which establish the common interest of mankind in space activities.

Thus there has emerged a common objective which can only be pursued in some ways by mutual effort, and



Military Applications. Communication satellite, right, and power conversion satellite, above, orbiting beyond the reach of effective interception, could be very valuable to the military.

in others can be more effectively attained by increased attention to cooperative procedures.

Fortunately there are already in existence a number of international organizations through which the scientific, engineering, and legal professions can work for the peacetime benefits expected to flow from the exploration and use of space.

A survey of these agencies — both nongovernmental and inter-governmental — was made by the United Nations Ad hoc Committee on the Peaceful Uses of Outer Space as part of the report which was unanimously approved on June 25, 1959 for presentation to the 14th General Assembly. The number and variety of the organizations which the Committee found to be concerned with space activities indicates that many scientific disciplines are required for success in this field.

It is not the sciences that are new, but rather that known sciences are being projected into a new environment with special challenges for the engineering and legal professions. The disciplines of physics, chemistry, astronomy, physiology and mathematics were organized into non-governmental scientific unions prior to the launchings of artificial earth satellites. In general they were engaged in the promotion of research, exchange of



information, and the publication of reports.

The remarkable vitality of the International Council of Scientific Unions was demonstrated when the efforts of the scientific community in 66 nations were directed toward the implementation of programs undertaken during the International Geophysical Year. The network of personal contacts, ideas, and resources developed during the IGY led to results from cooperative endeavors which won the admiration of the world.

The list of intergovernmental organizations with substantial interests in space activities is impressive:

The United Nations Educational, Scientific, and Cultural Organization (UNESCO) includes among its responsibilities the exploration of extra-terrestrial space and makes an annual grant of about \$200,000 to the International Council of Scientific Unions.

The World Meteorological Organization has worked since 1947 to establish worldwide networks for the improvement of weather information and its application to agriculture, shipping, and aviation. Artificial satellites will add greatly advanced techniques to facilitate the attainment of objectives which WMO has been pursuing all along.

The same point can be made for the International

Telecommunication Union which is responsible for coordinating the international use of communications. The ITU drafts the regulations which govern transmissions by radio, telegraph, telephone, and television. The allocation of radio frequencies to satellites is an extension into a new dimension of a task which the ITU is already performing for standard types of transmitters.

A similar situation may be expected to develop in the International Civil Aviation Organization whose functions concerning air navigation and transport will be affected by space craft which pass through air space to and from their journeys into outer space. The sphere of activity of this agency can be expanded or circumscribed, depending upon decisions to define these regions.

Future developments may cause the International Atomic Energy Agency, the World Health Organization, and the Inter-Governmental Maritime Consultative Organization to widen their present jurisdictions by including logical parts of the space sciences.

Four alternative forms of international organization can result from the fact that so many specialized agencies are concerned with important segments of the total space effort. New opportunities for expanding areas of peaceful international cooperation may be revealed by studies

(continued on page 42)

INDEXED BY P.A.L.

MACRO-LIFE

PART ONE: A leading space engineer examines some effects of science upon our social evolution

by DANDRIDGE COLE

During the course of a previous study of extraterrestrial colonies, it became apparent that certain political and social problems would become greatly intensified under the severe pressures of a closed and carefully balanced ecological system, in a hazardous, alien environment.

We can expect that a small scientific or military base on the moon or elsewhere in the solar system would be closely regulated and the personnel highly disciplined. We might also expect that much of this discipline would be self-imposed in the scientific base, but that rigorous control would be required in either case.

After an extraterrestrial base has become established and its value demonstrated, it is probable that it will gain permanent status. The recognition of the need for a permanent base may come much more quickly on the moon, for example, than in the Antarctic.

The high transportation costs in the early period of base support will necessitate the greatest possible degree of self sufficiency. It will soon be apparent that it is cheaper to send a trained agronomist to the moon to raise food for the base than to continue to transport all food supplies from the earth. Also geologists, chemists, miners, etc. will go to the moon to search for high grade ores of oxygen, hydrogen, carbon; and other critical elements, and to set up extraction and refining plants.

It will also become apparent that it is cheaper to send a man and wife to the moon, for five year tours of duty, than to rotate single personnel every six months. This economic advantage will be even more obvious if both man and wife are fully qualified specialists required to fill urgent assignments on the moon.

When, after the arrival of married couples on the moon, will the permanent base evolve into a colony? This may be more a biological question than a social or political one.

But once the colony becomes a reality, how long can the initial strict discipline continue? Pregnant women

and women with small children are notoriously difficult to regiment. We can expect some relaxation of controls in certain areas once children are present on the base. But historically we know that controls, once imposed, are difficult to remove. There is cause for serious doubt that the citizens of the extraterrestrial colony can ever enjoy the personal freedom of, for example, the citizen of the 19th century United States.

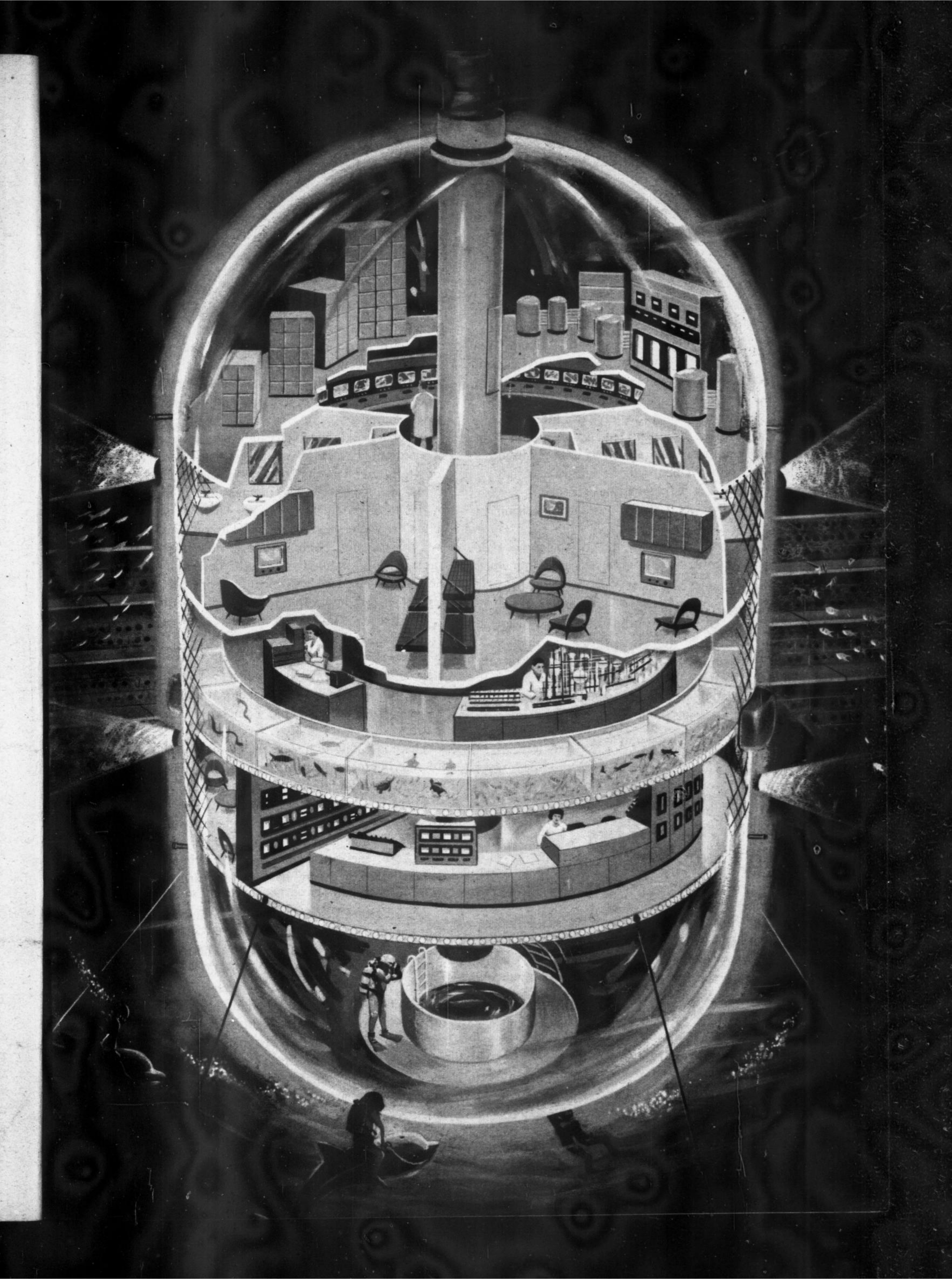
While we may have some concern about the social and political welfare of the moon colonists, a much more serious problem becomes apparent when we compare the extraterrestrial colony to our evolving civilization on earth. We note that the hazards and pressures which beset the moon colony are not so unique as they originally appeared. In fact, there is reason to believe that the extraterrestrial colony will be a small scale model of the human society of the future.

I make this observation because most of the restrictions imposed on the inhabitants of the moon colony will arise from high population density, the possibility of upsetting the careful balance of the closed ecology, the technological complexity required to sustain lives, and the high operational efficiency which the group must maintain. But these are simply extreme examples of problems already facing civilization on earth, and extrapolation of present trends indicate that the extremes faced by moon colonists will soon be world-wide.

It is generally believed that society will evolve without limit, that its form will constantly change, and that this change, hopefully, will in the long run be for the best. This belief is challenged here with the introduction of the concept of the Ultimate Society. Just as human population is growing toward an infinite number in a finite and rather short time so civilization is evolving toward a fixed, rigid, and ultimate pattern beyond which no further change will be possible.

The term "ultimate" like the term "impossible" is likely to provoke a negative reader response and neither

(continued on page 18)



Our present world will be transformed by science

term should be used without qualification. However, within certain carefully defined and limited areas, there are impossibilities such as self-contradictory ideas, for example, and likewise there are ultimates.

Within our present knowledge of thermodynamics, the Carnot cycles represents an "ultimate" although something beyond it is not necessarily completely impossible. The velocity of light represents an "ultimate" velocity within our present understanding of physics, but it is not necessarily impossible to exceed it, at least in some sense.

The term "ultimate human society" is a little frightening to us since it implies an end to social evolution — an end to social progress. We are used to thinking in terms of continuous improvement and the implication that we will reach a stable and permanent social form is abhorrent to Americans in general and to liberal Americans in particular.

The concept of the ultimate human society as described here is not intended to represent anything which will necessarily come about, at least in any particular form. Obviously, no one knows what the ultimate society will be like or even if the evolution of society will come to an end.

What is to be presented here is a very general picture of an ultimate society which appears to be the most likely end result of a number of trends which can be observed in present social changes, and which have been in oper-

ation centuries or even millennia. Some of these well established trends are as old as society, some are as old as life, and some are as old as the universe itself.

The disturbing aspect of many of these trends is that they seem to lead to catastrophe. When put in graphic form and extrapolated only a few per cent they lead directly to disaster in a disturbingly short time.

Some of these trends can be expressed quantitatively and can be accurately plotted. Others can be expressed only qualitatively. However, when put together they give a rather clear picture of a major cosmic event within the next hundred years.

A long-term trend which can be handled quantitatively and presented graphically is population growth. Another long-term trend is that of energy control and release. A few years ago this could be measured in tons of TNT in the form of high explosives. Then we were rudely jolted by the emergence of the kiloton bomb. Soon it was the megaton bomb. There is now talk in military circles of gigaton bombs which can destroy entire countries. Each of these steps occurring in a decade or less represents a thousandfold increase in destructive potential. It does not take much extrapolation of this curve to turn our sun into a nova.

There is an age-old trend in nature toward development of forms of matter which can transform energy in ever more efficient ways. There is the correlated trend toward more intricate and complex organizations of matter.

There is a long-term political trend toward larger political groupings which seems to lead inevitably toward a world government.

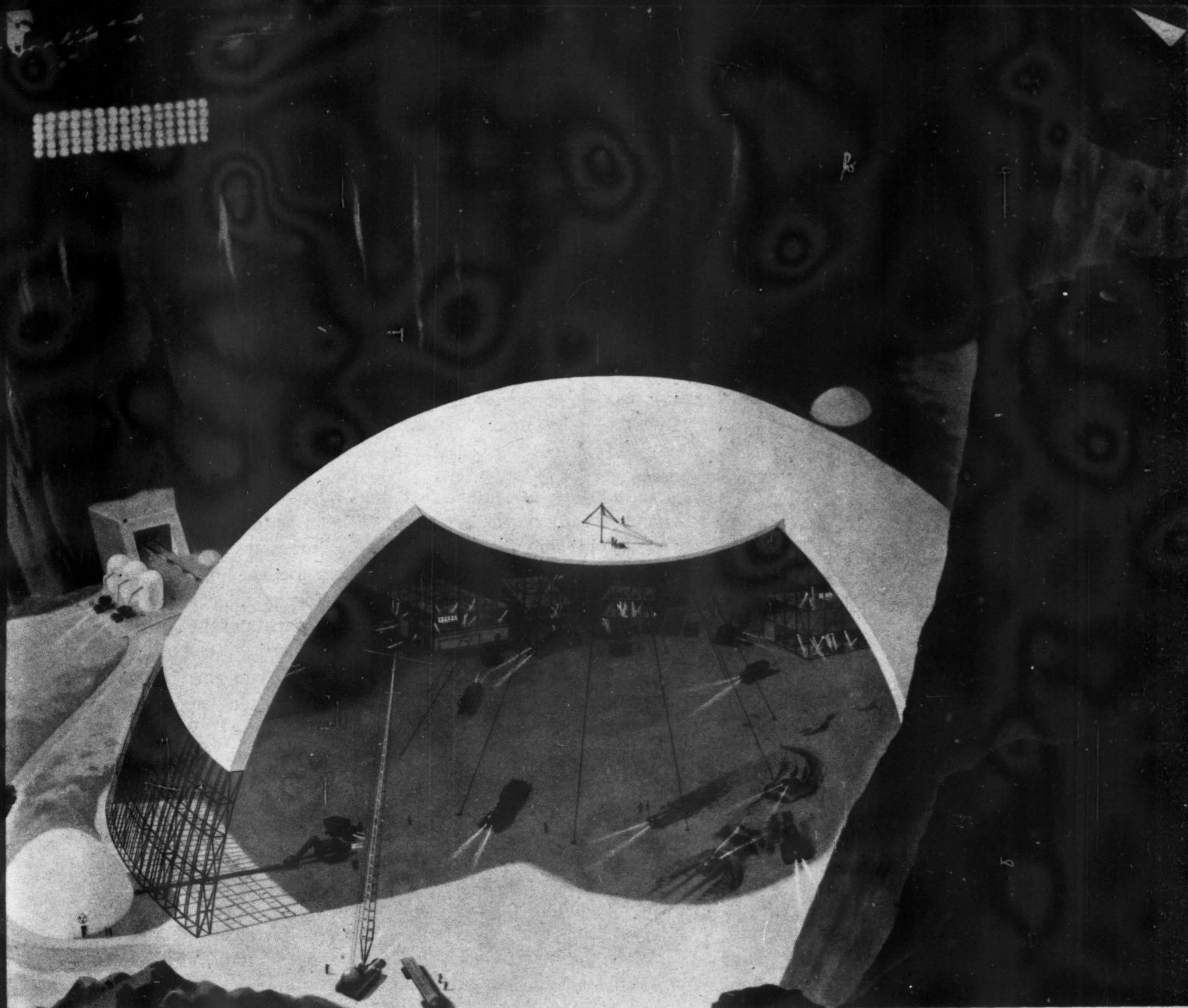
There is a contrary and highly disturbing tendency toward increased nationalism and the proliferation of new small "independent" political units. But the independence of these new countries is partly illusory as is demonstrated by the use of the "world army" to enforce order in the Congo.

The rate of acceleration at which our fund of scientific knowledge is expanding is greater than the rate of population growth itself. Higher productivity permits larger fractions of the population to take up science and we are rapidly improving our techniques of learning from nature. We are now making scientific studies of the process of creative thought and giving courses in creativity. Also we are just beginning to appreciate the practical value of basic research and even beginning to see some urgency in the discovery of new fundamental principles. We are heading for an explosion of knowledge comparable in magnitude and significance to the population explosion.

Other significant and well-known trends include the



Macro-life Colony. Artist's drawing shows self-contained community that is housed within a large, hollowed-out asteroid.



Lunar Colony. Constructed within the walls of a crater or a surface fault, the colony could eventually be self-supporting.

The high level of efficiency demanded by living in such a close knit colony would expose all occupants to severe strains.

increase in the life span and the trend toward machine labor. We are right on the verge of the final conquest of disease and the ability to replace worn out body parts. The time is not too far off when accidents and suicides will be the only major causes of death and the average life span will be at least doubled.

Besides taking over functions of the heart, the lungs, and the kidneys, as machines are about to do, they are replacing man in all types of labor. It has often been stated that automation may have consequences exceeding those of the industrial revolution.

The use of computing machines to aid or even replace man's mental functions, aside from other effects, will cause even greater increase in the rate at which we accumulate new knowledge.

While we might expect trends which have continued for centuries to go right on for centuries more, this may not be possible. The natural pattern is not for indefinite

increase but increase to a limit.

An explosive mixture of oxidizer and fuel may warm up gradually over a period of hours and days until the ignition point is reached. Then a chain reaction takes hold and there is an explosion which results in a stable chemical compound. An unloaded electric motor does not accelerate indefinitely — it flies apart. Pre-natal discomforts and labor pains increase only to a point and then end in birth. And it is an absolute impossibility that the population growth trend, as identified by von Foerster *et al*, will continue for a hundred years, since it leads to an infinite number of people in only 66 years. Of course, population growth could continue for an indefinite period, but not following the trend of the last two thousand years.

Social evolution will not continue forever or even for another century. Society will crystallize into a stable, permanent form. The cold war and the epic struggle for
(continued on page 44)



Recoverable Boosters

INDEXED BY P.A.L.

Our next generation of rocket engines will be designed

UP roars the powerful booster, shoving the other stages ahead of it through the thinning stratosphere and into the rarefied ionosphere. As the last drop of propellant is used up, its engine dies. The upper assemblage separates and roars on by itself as the second stage's own engine ignites.

Alone, burned-out, the useless hulk of the first-stage booster falls back into the sea unnoticed. It sinks to the Atlantic bottom, comparable in value to the golden cargos of ancient Spanish galleons lying nearby.

"Current practice to expend a vehicle on each flight . . . seems a little less than idiotic," says Captain Robert Truax, Director of Advanced Development, Liquid Rocket Plant, Aerojet-General Corporation. "Certainly no other form of transportation could be called economic if the vehicle were expended after one trip. For example, if an airliner were sacrificed on every cross-country trip, the fare per passenger . . . would be about \$30,000, an obviously prohibitive sum."

It is a plain fact that the single greatest cost of a multi-stage launching vehicle is the first-stage booster whose minimum price tag is \$1,000,000. This is the cheapest type, such as the Thor or Jupiter basic booster.

The Atlas runs up to \$3,000,000, while the Saturn will be an estimated \$5,000,000 or more per copy, even on a steady production basis after 1965.

This is only the actual hardware cost. If development costs were considered, proportionate to the number of companion boosters used and waiting, we can estimate that untold millions more in hard cash sink at sea with each launching at Cape Canaveral.

The successful launches might be said to be worth it. But what of the aborts? To the end of 1960, oddly enough, the USA had almost exactly the same number of successes as failures in attempts to place satellites into orbit—33 and 34 respectively.

The 34 aborts represented a complete waste of the first-stage booster cost, let alone the upper stages. But if those 34 spent rocket lofters had been recovered for another try, the cost of our space program would not have been so crushingly heavy in the first three years of the space age.

Well aware of the enormous drain of space funds caused by the "throwaway" boosters, our space leadership launched programs to study the possibilities of recovering boosters.

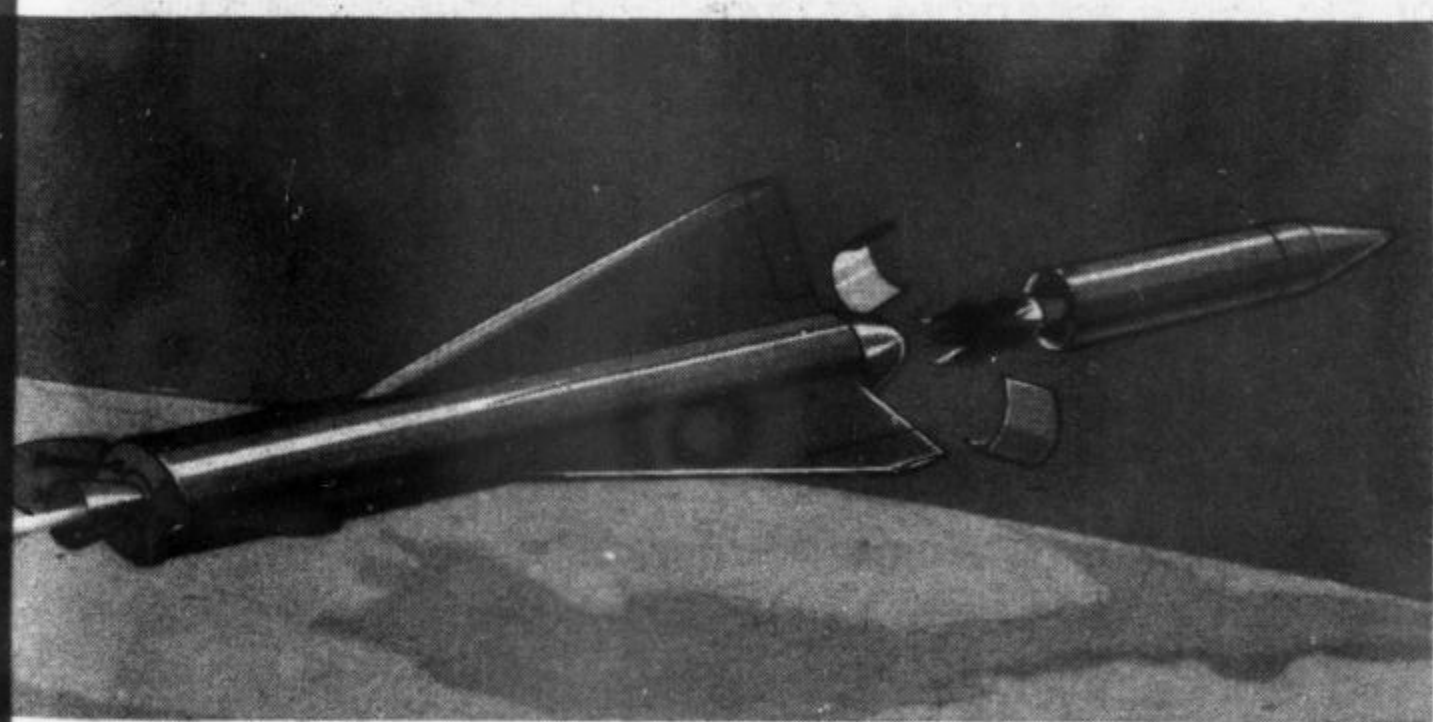
(continued on page 30)



Drag Recovery. Spent booster, left, will be slowed down by giant drag balloons before parachutes, above, are activated for final stage of descent. The specially outfitted cargo planes will retrieve the boosters in mid-air.

for recovery and multiple use

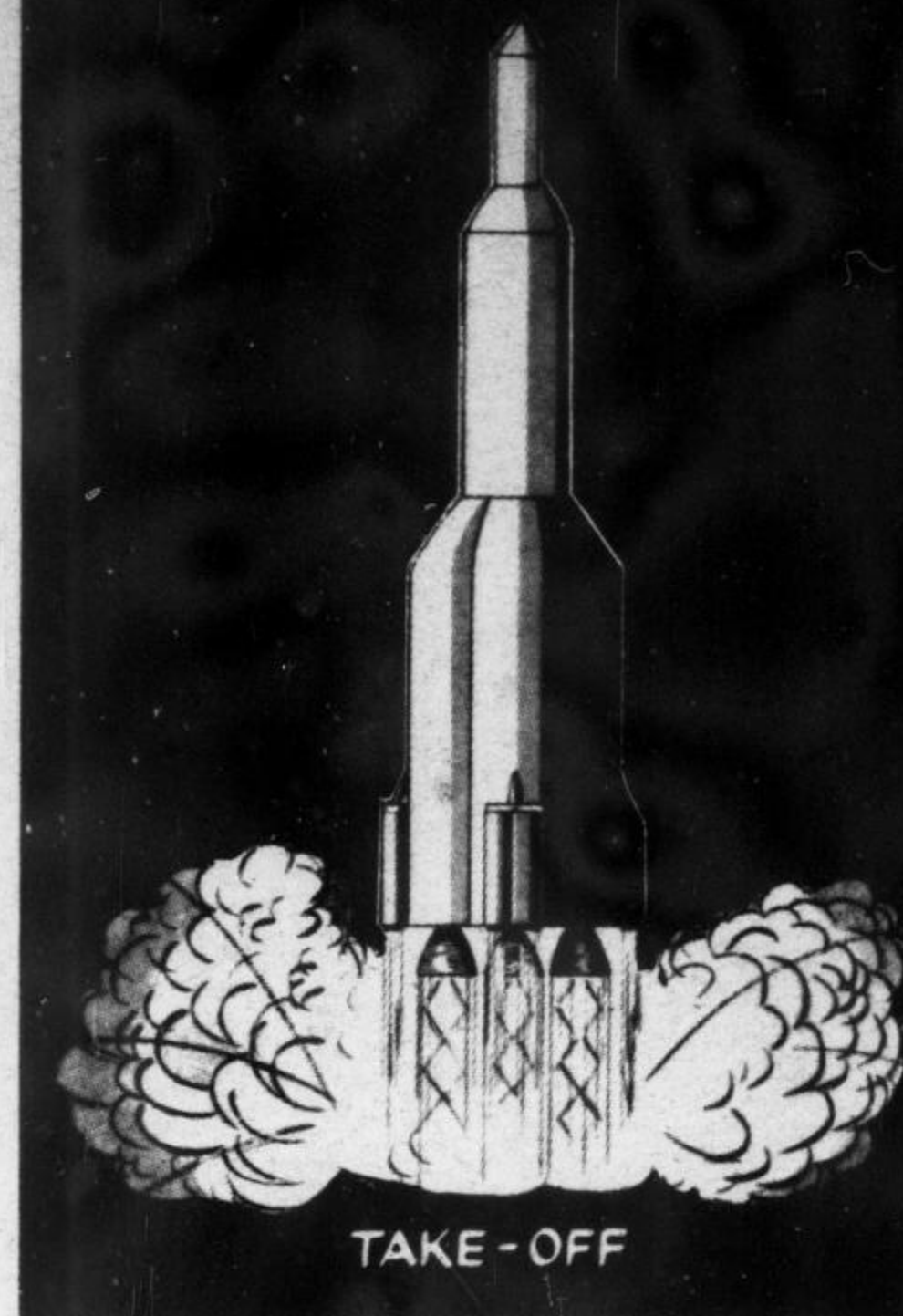
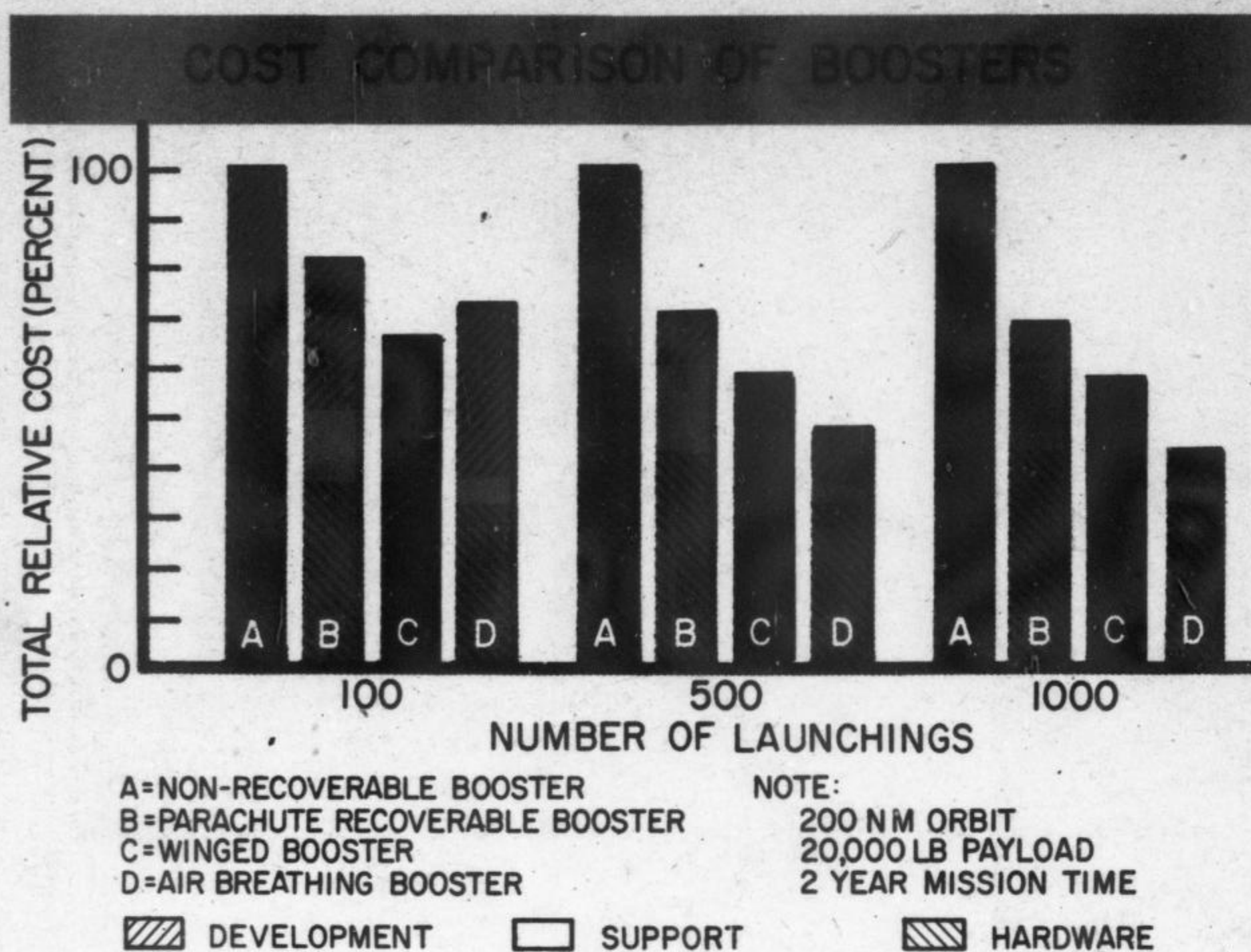
by Otto Binder



Aerodynamic Recovery. In this proposed design above, the booster will be equipped with aerodynamic wings that will enable the spent rocket engine to glide safely down to earth under the guidance of radio control from telemetric stations.

Parachute Recovery. This is probably the simplest method for recovering boosters after launch. Parachutes activated by barometric devices will unfurl to lower the empty rocket engine to earth. Landing will be made at sea to safeguard vital parts.





Multiple use of rocket engines will greatly reduce

From the start of our Saturn effort NASA thought of planning a recovery system for the Saturn booster. But due to the added engineering complexities and schedule slippages that would result, it was decided that the first models would not be retrievable. However, a recovery technique is being intensely researched now by Douglas engineers under NASA contract. Though details are not firm yet, the 3-part system may see use with Saturn C-2, slowing the giant empty booster of eight clustered liquid-fuel engines, their tanks, and their instrumentation for a gentle drop at sea where the package will have been designed to float. Towed back to the Cape by a tug, the \$5 million device could be refitted for use again and again to "truck" payload assemblies away from earth.

Recovery Payoff

Two factors make recoverable booster systems comparatively easy engineering jobs.

One is that 1st stage rockets burn out only 50 to 80 miles high, at a terminal velocity of 4500 to 7500 mph. They coast upward after separation from the upper stages but soon meet accumulative air-resistance and turn earthward. Their falling velocity is never high, creating far less troublesome problems than the re-entry of vehicles from orbit at a blistering 17,000 mph and up.

Secondly, after burning its propellants, the empty booster shell is considerably lighter. The fully-loaded weight of the Saturn first-stage, for example, will be approximately 1,000,000 pounds, of which about 800,

000 pounds are fuel and lox. Thus the empty booster, by simple subtraction, weighs 200,000 pounds. However, 100 tons is still not a featherweight contraption to lower safely to earth, and to do so will take considerable engineering skill.

There are two main disadvantages in all booster recovery systems. The first is the added weight penalty of the extra apparatus required. This will result in a certain loss of launch velocity. General estimates indicate that recovery apparatus will add 15% to 35% more to the booster's tonnage, depending on which recovery technique is used.

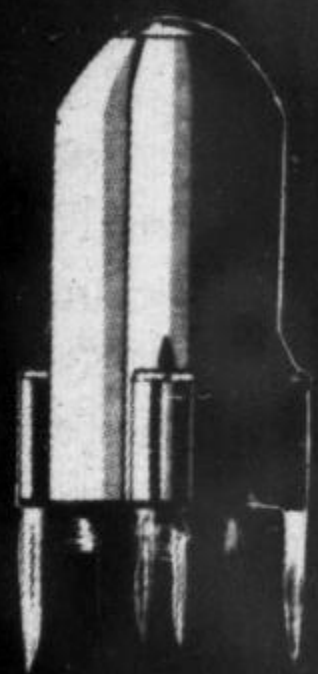
The second is that recovery expenses are not small either, and will run from 12% to 25% above booster cost. But this cost reduces steadily after a number of launchings with a single booster, in that the original R & D expense then becomes subdivided over and over. At an average 50 missions for any particular booster, the gross cost of research, development and construction reaches a tidy minimum.

The Saturn in 50 repeat launches would save at least \$350 millions on that basis, equalling a good share of the total funds poured into its development to date.

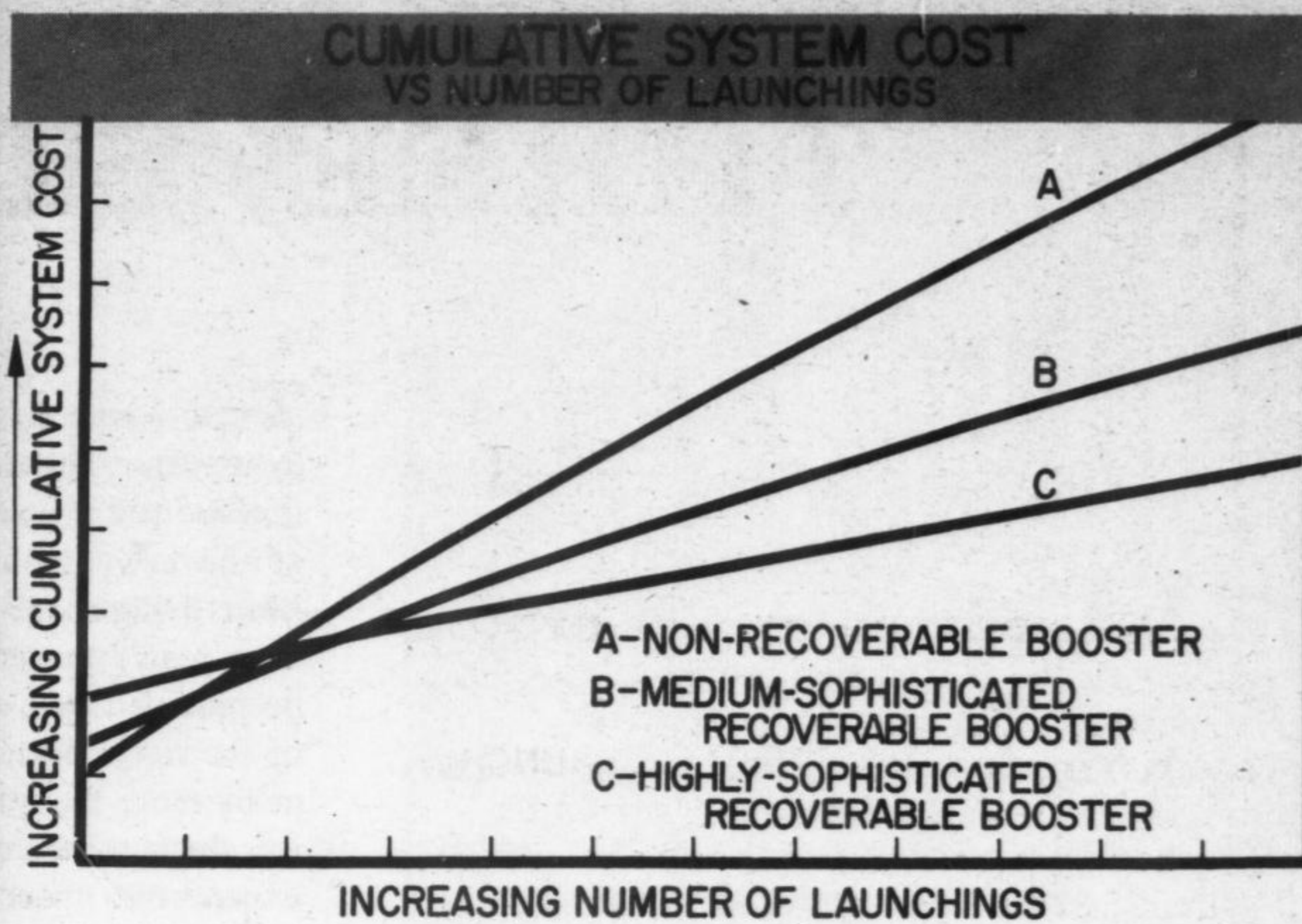
Besides NASA, the USAF and several aerospace firms are researching a variety of recoverable booster systems.

Under WADD (Wright Air Development Division) the USAF's Aerodynamic Deceleration Branch has made notable strides toward exotic methods of bringing boosters back. Convair, Lockheed, Goodyear,

Self-contained Recovery. Future giant boosters will contain retro-rocket system that will ease the boosters down for a safe landing.



LANDING



the extremely high costs of present space operations

Aerojet-General, AVCO, and Kaman are some of the private firms working on more conventional techniques that will be operational sooner.

Many Methods

David J. Jones and John O. Tearnan of Convair base their technique on a booster whose burnout velocity is between 5000 and 7500 mph and whose final altitude would be 50 to 80 miles. Incorporated in the booster would be a retro-rocket system for the first slow-down, plus an auxiliary air-breathing jet engine for the final descent. The latter, of course, could only operate at 20 miles or lower where it finds atmospheric oxygen to burn its fuel.

The booster would have wings that are retracted during its powered ascent. Then, after burnout and during the fall, the wings spread out and the combination rocket-jet powerplant accomplishes an aerodynamic descent under radio-command from the ground.

Splashing down at sea no more than 100 or 200 miles east of Cape Canaveral, the booster could be easily tracked by the Downrange facilities and picked up by the same Navy fleet that retrieves nose cones and Mercury capsules.

This system would be the most technologically complex and expensive but it would have the greatest reliability.

It has been suggested that in later versions, for manned space missions, this booster could also be manned. The pilot, isolated from the top-stage crew in his own small booster cabin, would guide the empty

shell down after burnout.

When manned flights are fairly common, this piloted and reusable booster may prove to be the least expensive since the man would replace many guidance and control gadgets.

Goodyear engineers offer their ballutes as a solution to the problem of unmanned booster recovery in the near future. Already tested in 12-foot pilot models for bringing research rocket payloads down safely, these inflatable drag-balloons have proved capable of preventing a spinning or a spiraling descent.

Such abnormal motions downward at high-g forces could damage the booster and deliver battered junk beyond repair.

For speeds from Mach 4 to 10 (about 2500 to 6500 mph) Goodyear engineers believe their re-enforced ballutes can hold up under all aerodynamic strains and re-entry temperatures to slow down the booster rapidly, for a final parachute landing. Ballutes larger than the 100-foot Echo are feasible, if they are constructed of much stronger inflatable materials (see article *Inflatable Devices*, in the August issue).

The Goodyear system has the advantage of low weight and bulk in the ballutes that could easily be folded during ascent and inflated in space. Also, costs would be minimal. Its disadvantage would be an unpredictable landing area, since the balloon-hung booster, before its splashdown, would be subject to the vagaries of winds in the lower air.

AVCO engineers are working up their own "dive

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THREE STEPS TO T

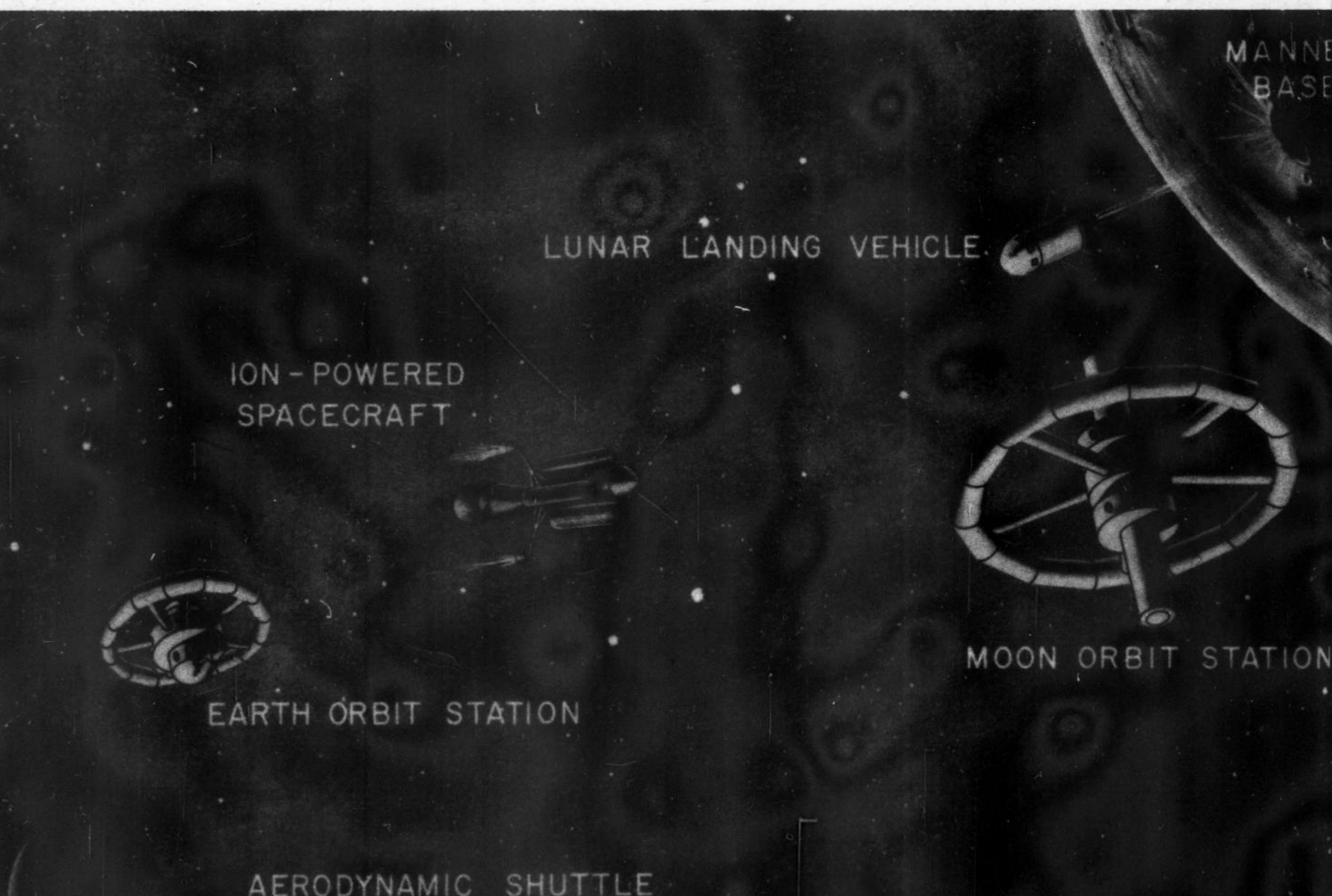
**A leading space scientist
discusses a new orbital
technique that will ease the
problems of moon transport**

by ROY BRERETON

INDEXED BY P.A.L.

TODAY, man stands on the verge of a new era—the Space Age. The driving forces of the industrial revolution are still present, but the social and economic forces of the new age are becoming increasingly important. More living space and resources are required to sustain even man's present standard of living, and these can be provided by exploitation of the space and resources of the other planets and satellites of the solar system, or by more thorough utilization of terrestrial resources. But the latter are definitely limited; therefore, man must expand into space, and it is anticipated that the Space Age will have a primitive beginning on the earth's nearest celestial neighbor—the moon.

Conquest of the moon, because of the development and research that are needed in space technology, will evolve through several steps. The first step, consisting



O THE MOON

of all types of earth-based observations, is now nearing completion. It is being replaced by the second step, represented by the series of unmanned exploratory rockets designed to impact on the moon, orbit the earth-moon system, circle the moon, and finally to soft-land an instrument package on the lunar surface.

This second step will provide most of the geological, astronomical and biological information required to plan a manned lunar flight. As an example, one of the things we must know about the space between the moon and the earth is the type and amount of radiation found there. During times of solar flares and sun-spots, the so-called cis-lunar space as well as the lunar surface are possibly death-traps of lethal radiation.

Before man sets foot on the moon, not only must we have detailed information on the type and amount of space radiation, but we must know its effect on living organisms. Thus, clinical specimens—mice, rats, and even a monkey—clothed in protective garments—will be exposed for several days to these effects on the moon's surface.

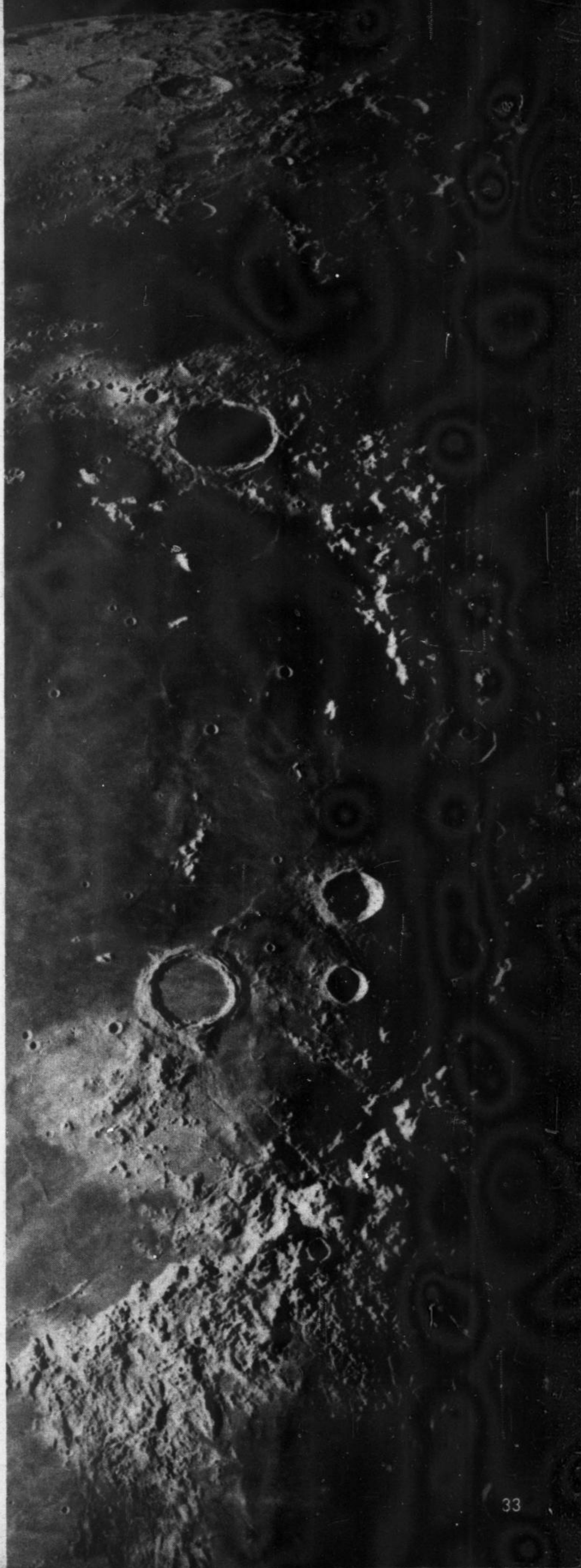
In addition to these radiation experiments with animals, tests must be made to detect the presence of dangerous organisms. The virology of the moon must be carefully examined, not only to protect the health of the first landing party, but to prohibit the spread to earth of lunar organisms, if any, that could flourish under terrestrial conditions and perhaps cause worldwide sickness and death.

BEFORE man lands on the moon, scientists must gather detailed knowledge of the structure and composition of the material that overlays the lunar surface. Astronomical studies indicate this material is dust-like in nature, but its specific physical properties are virtually unknown. For example, if this dust is composed of nickel-iron meteor particles, its magnetic properties could cause it to stick to charged landing and surface vehicles or cause difficulty in the operation of equipment.

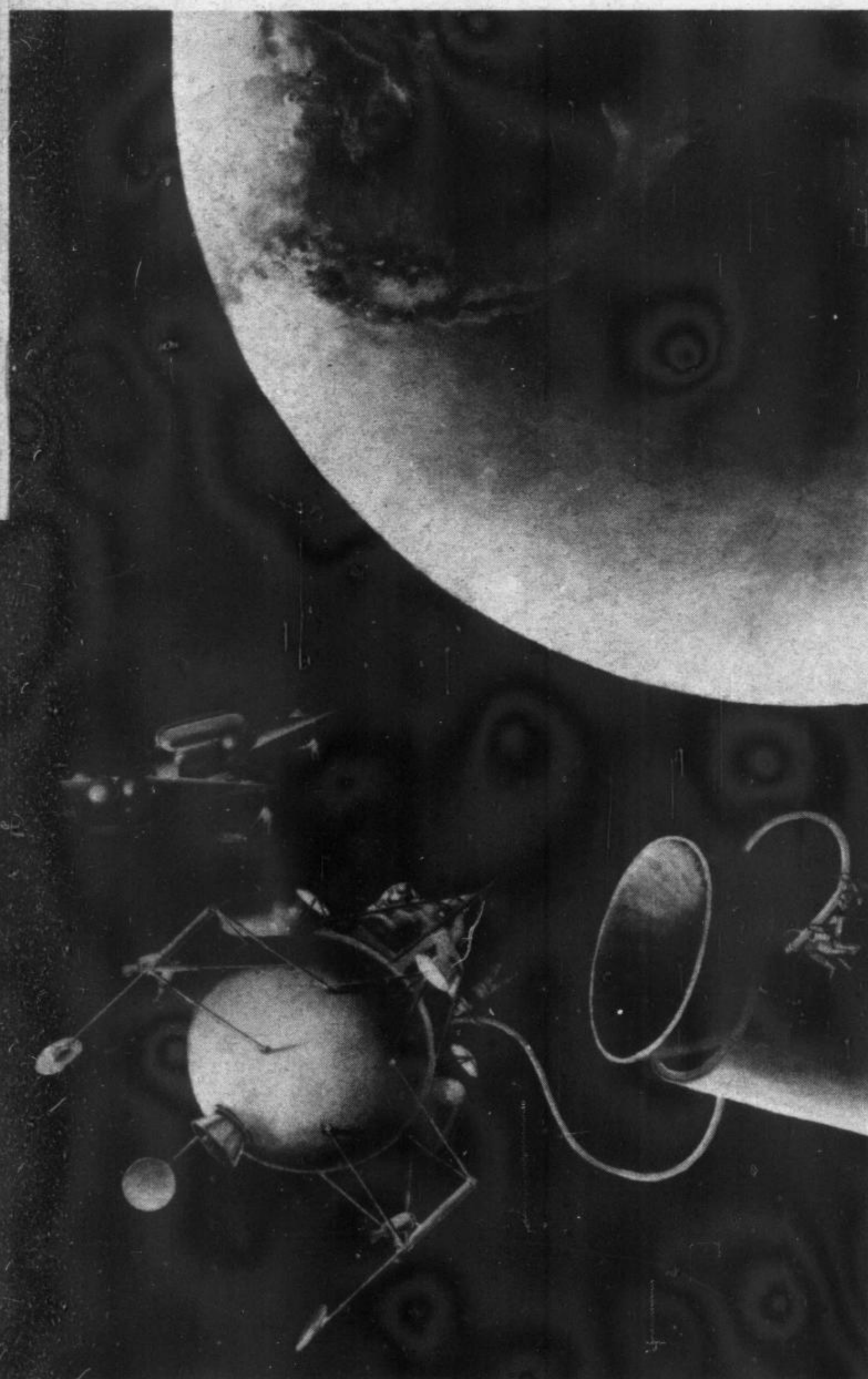
Further, if this dust has accumulated into thick unstable drifts because of solar winds or lunar topographic forms, it would represent a treacherous sliding surface to be solicitously avoided. It is most important that the landing vehicle settle onto a firm level surface, and

(continued on next page)

Lunar Conquest. Technique calls for two space stations, in orbit around moon and earth, to serve as steps to the moon.



Orbiting space stations will serve as fuel ports and vehicle changing stations



Refueling Operation. Artist's conception shows space vehicles taking fuel at earth-orbit station. Aerodynamic ships will act as shuttle between the earth and the orbiting station.

not one covered by dust that will be caught up in the thrust of the landing-jets to form a "fog" and conceal the surface during the delicate operation of landing. Or the dust might cover and hide fissures and crevasses into which the vehicle could slip, with disastrous results to both the moon ship and its crew.

Specific environmental facts that must be determined before landing are as follows:

1. Type and amount of both corpuscular and electromagnetic radiation incident upon the lunar surface during times of normal solar activity and during solar storms.
2. The structure and nature of lunar dust.
3. Physical properties of the lunar surface.
4. Traffic conditions of the surface.
5. Frequency and size of meteorites. (A solution to this problem can be extrapolated from terrestrial studies.)
6. Hazards to manned operation.
7. Virology.

The third step in the conquest of the moon will be characterized by more powerful rockets and greater scientific sophistication, thus permitting manned exploration.

THE first manned lunar flight will most logically be a highly elliptical trajectory that will carry the space vehicle in an orbit around the earth-moon system, but will not land the craft on the moon. This first circum-lunar flight will have more prestige and political value than scientific, and from an escape and survival standpoint for the human passenger, it will be a very hazardous undertaking.

Preliminary manned lunar exploration will probably be carried out directly from the earth with huge multi-stage rocket vehicles; however, the plan for a thorough manned lunar exploration program will be much more complicated for it will require the development of a stepping stone, or staging platform, in space.

It is economically and technically impractical, and certainly very hazardous for many flight personnel—both scientific observers and crew members—to attempt to establish and maintain lunar exploration parties directly from an earth base; therefore it is anticipated that large-scale manned exploration of the moon will be carried out from a huge earth-orbiting satellite that will serve as a supply platform for flights between the earth and the moon.

This space station will be fabricated in orbit from components delivered by aerodynamic-rocket vehicles, and it will be large enough to serve as a supply base for lunar flights, as a facility for assembling true space craft, and as an astronomical observatory. It will be located at an altitude just beyond the fringes of the earth's atmosphere.



Lunar Landing. Artist's drawing shows rocket landing on moon with aid of retrorockets that ease it to surface.

The results of scientific observations by the early lunar exploration teams will form the procedures and objectives for establishing a permanent colony or base on the moon. This permanent facility will mark the beginning of the final conquest of the moon.

The selection of the optimum site for a permanent lunar base depends on the interrelationship of several requirements, as given below in general order of importance:

1. The site should not be subject to extremely high temperatures, as would characterize the lunar surface from the equator to salenographic latitudes 45° north or south, because of the waste-heat-rejection problems and the difficulty of insulating equipment, vehicles and even the feet of space suits against temperatures ranging to perhaps 150°C .
2. The site should be located in a position favorable for maximum use of solar energy.
3. The site should be comparatively near a natural-resource potential.

SITE selection compatible with the above requirements will demand the solution of subsidiary problems bearing on the nature and structure of the lunar surface, lunar resources, operational accessibility, type of base-power supply, and certain geophysical, geological and astronomical considerations.

Previous studies have often depicted the lunar base as a dispersed array of buildings, storage tanks, and launching sites all boldly exposed on the surface of the moon. The tenuous lunar atmosphere will probably offer little protection for men and most equipment against normal solar radiation. Solar and cosmic storms will unquestionably make the immediate lunar surface a death-trap of lethal radiation.

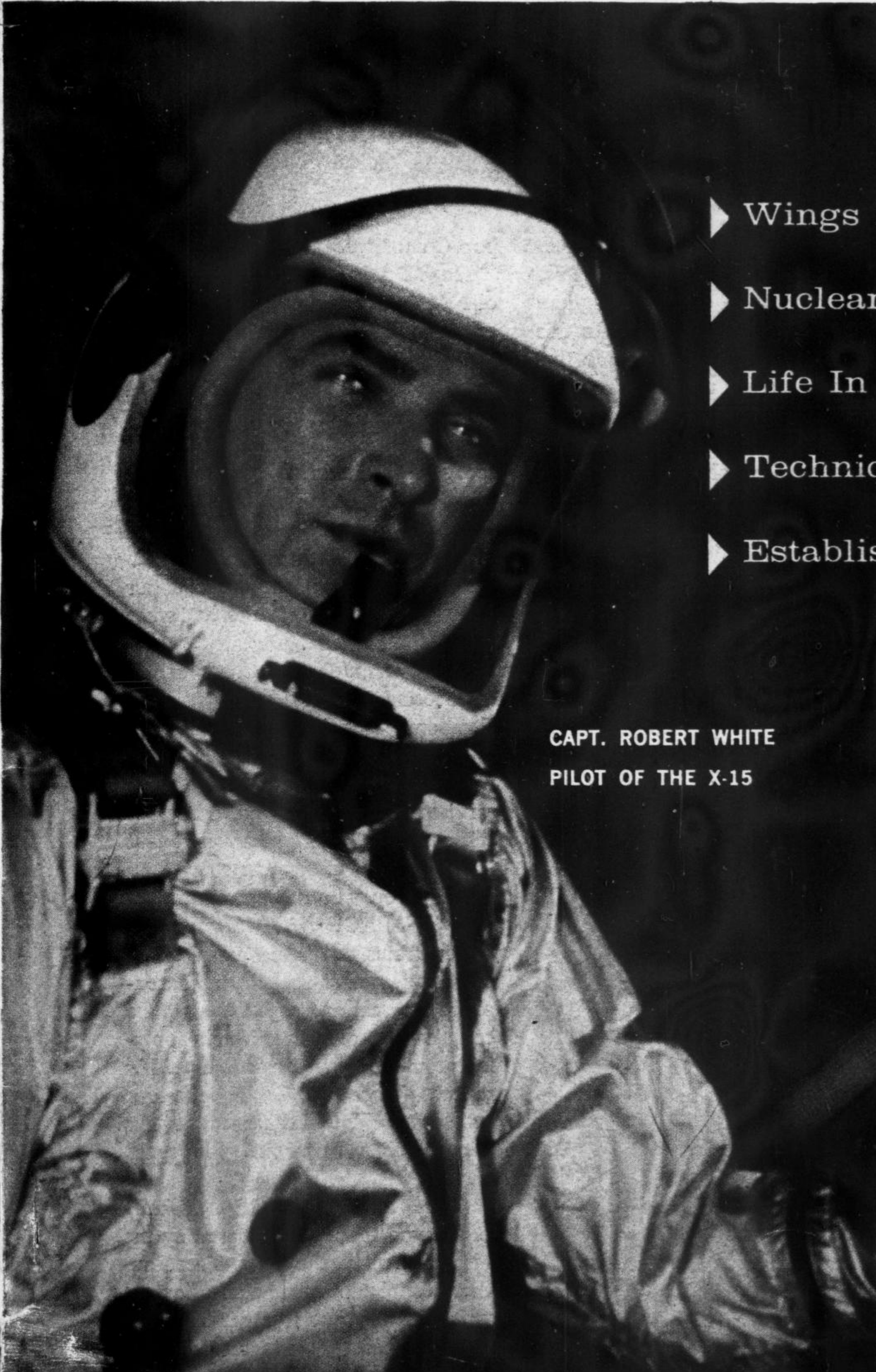
For this reason, the permanent abode for men on the moon will have to be located like a mole-hole under the surface, or else constructed in trenches on the surface and then covered with indigenous fragmental rocks. This method of construction will impose many design and building limitations and require techniques of excavation and construction that have not been ex-

(continued on page 60)

SPACE WORLD

APRIL 50c
VOL. 1, NO. 7
1961

The news magazine of Astro-Science

- 
- ▶ Wings Into Space
 - ▶ Nuclear-Powered Rockets
 - ▶ Life In a Missiletown
 - ▶ Techniques of Space Refueling
 - ▶ Establishing a Lunar Colony

CAPT. ROBERT WHITE
PILOT OF THE X-15

SW 14
PACIFIC AERONAUTICAL
7660 BEVERLY BLVD-LIBRY
LOS ANGELES 36 CALIF

Willy Ley • Hugh Dryden • John W. Clark • Charles E. Kaempfen

APRIL 1961
VOL. 1 — No. 7

SPACE WORLD

ABOUT THE COVER



Cover shows Capt. Robert White, USAF test pilot, preparing to board X-15 rocketplane prior to recent flight test. A new model of the experimental craft is expected to set altitude & speed records.

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CONTENTS

ARTICLES

- 10 **WINGS INTO SPACE**, by Ernest Haussman
A USAF proposal: winged vehicles able to operate in air and in space.
- 14 **NEW MONITORS FOR ASTRO-SCIENCE**, by Hugh L. Dryden
An NASA report on scientific satellites now being prepared for orbit.
- 18 **SPACE WEATHERMAN**, by John Royce
An interview with Sidney Sternberg, the chief engineer of Project Tiros.
- 20 **PROJECT ROVER**, by Willy Ley
Nuclear powered rockets — the theories and their practical applications.
- 25 **MISSILETOWN, USA**, by John Rublowsky
A small community solves the problem of living with a space industry.
- 28 **MOBOTS**, by John W. Clark
Remote control servo-mechanisms can perform a variety of space jobs.
- 32 **LUNAR COLONY**, by Otto O. Binder
The first in a series of articles describing future extraterrestrial bases.
- 37 **SPACE REFUELING**, by Charles E. Kaempfen
A unique proposal that may change our thinking about space transport.
- 40 **1:USSR; 2:USA; 3:???, by Robert Granville**
Here are the leading candidates for third place honors in the space race.

DEPARTMENTS

- 4 **LETTERS TO THE EDITOR**
- 6 **ORBITING AROUND**
- 24 **WHAT'S NEW**
- 36 **BOOK REVIEWS**
- 43 **NAMES IN THE NEWS**
- 45 **SPACE QUIZ**
- 47 **RUSSIAN REPORT**
- 49 **SPACE VEHICLE #1: THOR**

WINGS INTO SPACE

INDEXED BY P.A.L.

by **ERNEST HAUSSMAN**

Various ungainly shapes, purely functional in design, have been proposed for the ships that will carry man through space in the future. Since there is no air resistance in space, orthodox streamlining of spaceships (as in aircraft) is unnecessary. However, this is true only for craft that will start from an orbiting space station and return there, without descending to earth.

On the other hand, the negotiation of *aerospace*, which includes both air and space, is a different matter entirely. In this mixed realm of operation, both aerial and space flight techniques must be combined in a single vehicle in order to effectively patrol earth's vicinity.

To meet this need for double duty, the United States Air Force has developed two programs, the series of X rocket planes and the Dyna Soar vehicles, hybrid children born of the union of the airplane and the rocket.

The X rocket planes and the Dyna Soar are winged, for maneuvering in the air. In space both these vehicles are turned or steered by vernier rocket blasts. Both types of vehicles must first be carried into space before they can operate. The X plane requires a jet plane to raise it to an altitude of some 45,000 feet before its own rockets ignite. The Dyna Soar must be aided into orbit or into its space glide by a Titan's thrust.

Until recently this booster system, whether by jet-plane or ICBM, seemed essential for all such aerospace vehicles.

Not so, now. The United States Air Force has dropped a blockbuster into the whole concept of the man-in-space program. Briefly, the USAF proposes a super-powerful Space Plane which will take-off from the earth's surface for an orbiting jaunt, then land back on the ground—all under its own power.

Such a Space Plane would still be a cross-breed of two fundamentally unrelated control systems operating in two different mediums. It will be under the usual aerodynamic control of wing-flaps, ailerons and tail rudder within the atmosphere. In space, it will use the control technique of thrust-reaction by jets of gas and retro-rockets.

Despite criticism of its hybrid nature, the USAF feels the Space Plane is not a stop-gap compromise but a soundly conceived vehicle that will be the ideal manned spacecraft for most aerospace missions, military or civilian. Furthermore, the Air Force experts maintain that

Aerodynamic vehicles, able to operate in both air and space, are prototypes for manned space-craft to come

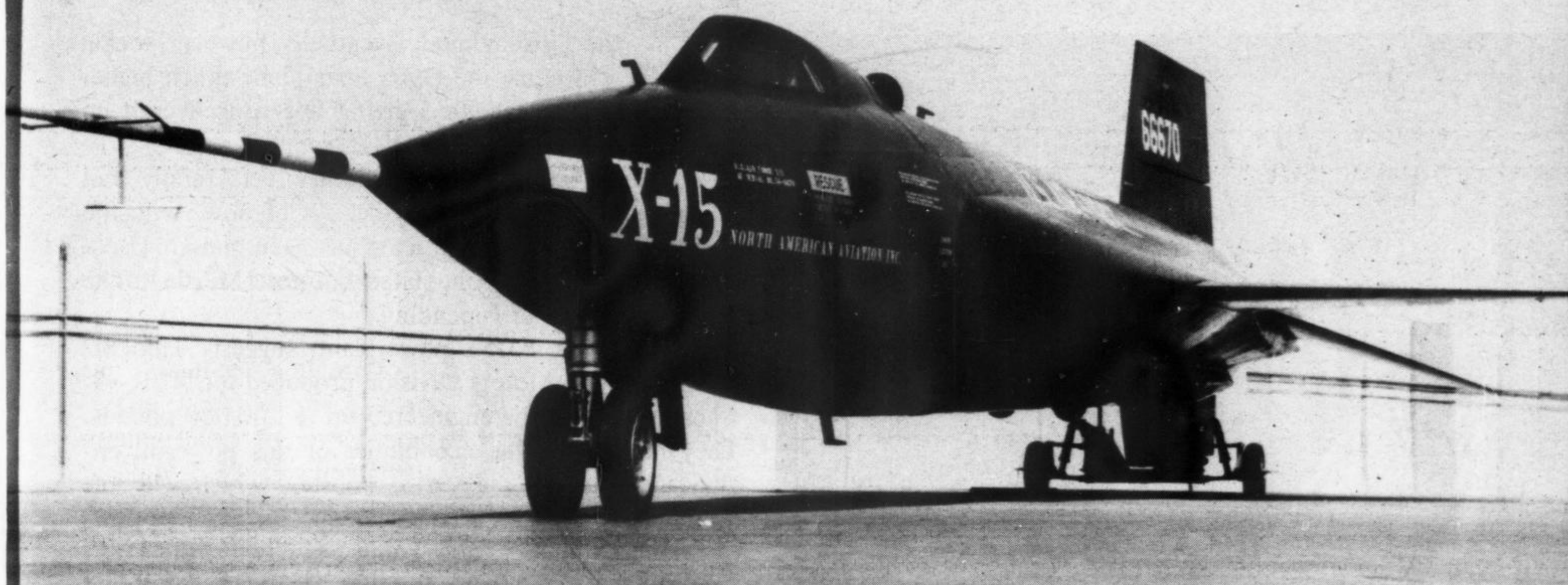
their winged series of the X-15, Dyna Soar, and Space Plane holds far more promise for the long run than NASA's Mercury Capsule or any wingless vehicle. Even NASA admits its Mercury, and follow-on 3-man Apollo vehicles are not the best models for true spaceships to come.

The USAF and NASA are now vying for major control of our man-in-space effort. The USAF claims it has the most urgent reason for having this control: its stewardship of the national security. The matter is pending, but the USAF is meanwhile continuing its wings-into-space research under Lt. General Bernard A. Schriever and his Air Research and Development Command (ARDC).

The X-Planes

Since 1946, the ARDC has devised a series of X planes (X for experimental). First designed by the NACA (National Advisory Committee on Aeronautics) with an assist from the Navy, the rocket plane project was transferred to the USAF for full development. The flat salt beds of Rogers Dry Lake at Edwards Air Force Base in California was chosen as ideal for takeoffs and landings.

The X-1, built by Bell Aircraft (now Bell Aerospace) was ready for powered flights in December, 1946. In October 1947, USAF pilot Capt. Chuck Yeager became the first man in history to break the sound barrier when he took the flying missile over 900 mph. The X-1 was eventually scrapped for the more powerful X-1A and with this Yeager also passed Mach 2 in



X-15. This rocket-powered, experimental plane, developed by the USAF, established new altitude and speed records.

December 1953, reaching 1,650 mph.

When the X-1A was superseded by the Bell X-2, Capt. Iven C. Kincheloe coaxed it over 115,000 feet high where no jet plane could breathe the rarefied air and above any manned balloon flight. In that same year of 1956, Capt. Milburn G. Apt crashed to his death in the X-2, but not before his instruments had recorded a new world speed record of about 2,000 mph.

Other experimental jet planes, not rocket powered, took the ARDC numbers from X-3 through X-14. The X-2's successor thus became the X-15. Three airframes were built by North American for the X-15. One was destroyed when the engine exploded on the ground just before a test flight in December, 1959.

The second X-15 was run through powered tests in August 1960 to crack the X-2's height and speed records. With NASA pilot Joe Walker at the controls, the black, needle-nosed X-15 split the stratosphere at a phenomenal speed of 2,196 mph. A week later, USAF pilot Major Robert White took it up to the fringes of space, 26 miles high.

This was done with the XLR-11 (Experimental Liquid Rocket) engine, rated at 16,000 pounds of thrust. The third X-15 has meanwhile been fitted with the engine it was originally designed for, the XLR-99, which develops a thrust of up to 57,000 pounds. Burning ammonia (NH_3) and lox, it is capable of hypersonic speeds beyond Mach 5, anywhere from 3,500 to 5,000 mph., and a maximum altitude of around 100 miles. Scott Crossfield, who first tested the high-powered XLR-99 in November 1960, said the X-15 would ac-

complish its goals easily.

In the atmosphere, the X-15 is aerodynamically controlled by its pilot with the conventional wing flaps and tail rudder. But when the plane rises beyond 35 miles from earth, where the thinning stratosphere can no longer support any craft or influence its path, the X-15's pilot uses jet-steering. Gases produced by hydrogen peroxide spurt from three sets of twin vernier jet holes. Three sets of jets are required for maneuvering in the three dimensions of space. One set of two holes in the nose spurts gas jets either up or down, controlling *pitch*. Another set, positioned right and left of the nose, controls sidewise *yaw* movement. The third set of two jets are in either wing, one spurting up, one down, to control *roll*.

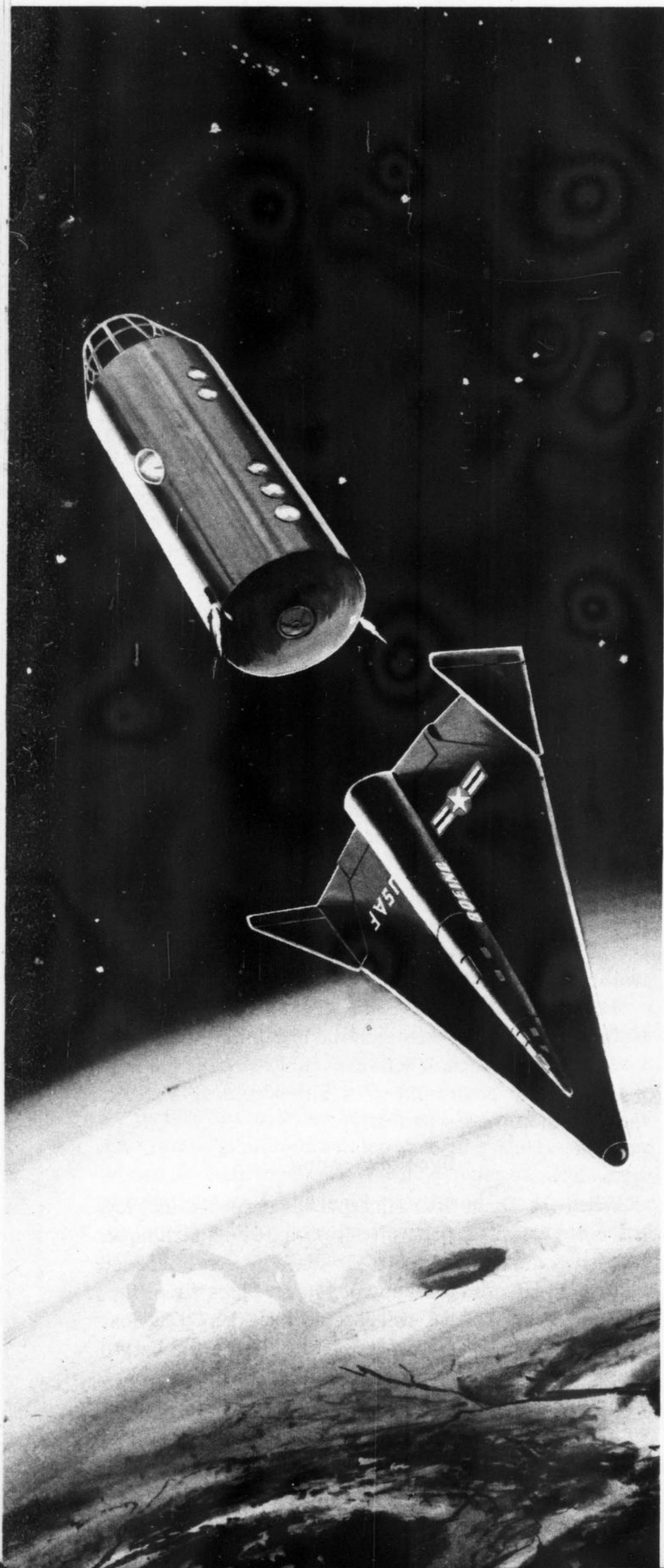
Tests in high-altitude flights where aerodynamic control is almost absent answered the important question of whether these reaction jets can safely steer a plane in the unearthly environment of airless space. Verdict: the jet system works perfectly.

Dynamic Soaring

When the Dyna Soar concept was proposed in 1958 it seemed a radical departure from the X-15 technique. But it wasn't really. Where the X-15 is slowly carried aloft some 10 miles for launch by its jet-plane "booster," a Titan rocket booster will instead hurl the Dyna Soar upward before its own engines ignite. Later, the Saturn booster will serve for bigger multiple-man Dyna Soars.

Actually, the tests of the first Dyna Soar boost-glider will be made as an air-drop from a B-58 jet bomber,
(continued on next page)

Manned, earth-to-orbit capability is USAF goal



quite like the X-15 method. Eventually, however, rocket boostings will carry the Dyna Soar plane much higher and at greater speed, thus giving this winged craft an orbital capability which the X-15 cannot achieve.

The Dyna Soar may show another X-15 family trait—if they share the same engine. As of now, only the Dyna Soar airframe contractor has been chosen (Boeing) and the firm for the Titan booster (Martin). The choice of the motor is pending.

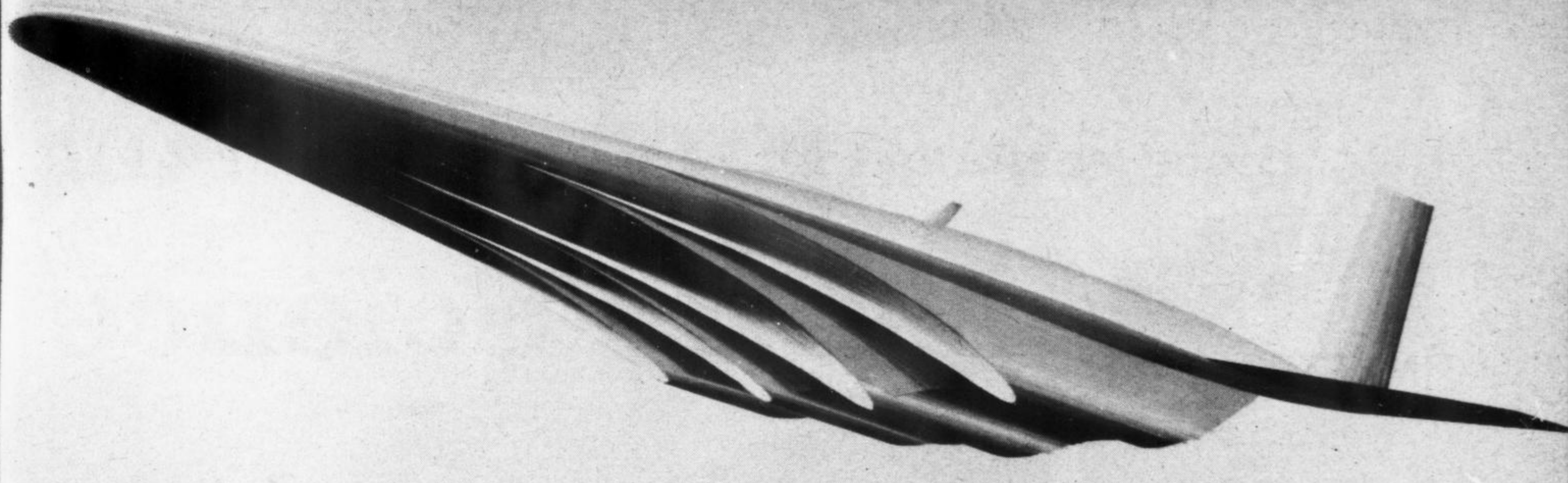
Why not the X-15's powerplant, suggests Thiokol? Their Reaction Motors Division produced the XLR-99, whose thrust can be engineered up to 100,000 pounds. They have listed the capabilities of this powerful engine according to the varied boosters which will loft the Dyna Soar. With a B-70 launch (the USAF's newest Mach 3 bomber, now being test-flown), the Dyna Soar, with an XLR-99 installed, could go into low orbit and achieve a glide to earth. With the Titan boost, it could reach high orbit and maneuver down through several other orbital positions before lack of fuel necessitated re-entry to earth. With the Saturn's super-kick, the Dyna Soar could carry along additional fuel reserves and maneuver at will above the world for long periods, much like a jet-plane lower down in the air. Finally, boosted by Nova, a Dyna Soar could soft-land its pilot on the moon with enough reserve fuel for the return trip to earth.

The Dyna Soar's steering system in open space will be basically the X-15's system, using sets of vernier jets controlling pitch, yaw and roll.

One difference between the X-15 and Dyna Soar is in the metals used for their fuselages and outer metallic skins. The X-15's Inconel-X body, a nickel-alloy, will withstand heat of 1,200 degrees F., the maximum temperature the rocket plane will encounter. Since the Dyna Soar will re-enter the atmosphere at speeds that will double that air-friction temperature, a more refractory metal had to be found. Molybdenum is the answer, a metal in limited supply, hitherto used only for special alloy steels. The Dyna Soar's outer skin will be pure molybdenum, whose melting point is near 4,500 degrees F.

According to the present schedule, Dyna Soar will begin tests in 1963 and become operational early in 1965. But the Dyna Soar and its ancestral X-15 will always require the crutch of a separate jet or rocket booster system to launch them into the heights. On

DYNA SOAR. Boosted into orbit by a Titan ICBM, this rocket-powered glider, under control of the pilot, can skip across the upper fringes of the atmosphere, re-enter, and then land on earth.



SPACE PLANE. Giant space-craft, proposed by the USAF, will manufacture its own supply of lox from oxygen in the atmosphere.

earth's surface, both are forever grounded.

The USAF's Space Plane will takeoff from the ground under its own power and soar up through the air into space. But how? If neither the X-15 nor Dyna Soar, both huge vehicles of 15-plus tons, can carry enough rocket propellant to accomplish this feat, how will the Space Plane do it?

Surface to Space

The answer is to increase size and fuel capacity, combined with an ingenious breakthrough idea of the space age. The Space Plane will only carry a supply of liquid hydrogen fuel at take-off and will gather its lox later, right out of the great oxygen reservoir that surrounds earth—the atmosphere.

To do this, the Space Plane must first leave the runway with conventional turbojet engines, aided by RATO. At turbojet breathing limits, around 20 miles altitude, a secondary ramjet engine will be turned on which can operate in more rarefied air. This powerful motor will drive the craft over 50 miles high and attain a speed of Mach 18, about 12,000 mph.

Then the pilot will turn parallel to the earth's surface and stay within the upper stratosphere. At this point a large scoop opens in front of the plane to gobble in the thin air and cycle it through a compact cryogenic unit, converting it into liquid air. The next cycle fractionally distills the useless nitrogen out of the mixture.

It will be no small feat for a plane to gulp in and liquefy huge quantities of air. But the USAF explains this will be feasible through the use of liquid hydrogen fuel at a temperature of 423° below zero F. An extra reserve of this frigid fluid will be used to liquefy the indrawn air through standard heat-exchange techniques. A small amount of liquid hydrogen turning gaseous can freeze a large amount of air.

The evaporating hydrogen gas that results is not wasted, but is used to run the ramjet engine which is moving the craft along at high speed. Also, the ramjet engine's heat is then cycled through for fractional distillation of the oxygen out of the nitrogen. Boiling at minus 297½ degrees F., oxygen separates from the

colder liquid nitrogen that boils at minus 320 degrees. Later, before the useless nitrogen is allowed to evaporate and escape from the plane, it is re-cycled to absorb heat and again cool the oxygen gas into a liquid, which is retained.

By this complex juggling of cryogenic principles, which has been called "using-even-the-pig's-squeal" technique, the Space Plane will be able, the USAF believes, to manufacture its own lox at heights of between 50 to 65 miles. The near-zero air resistance will allow the plane to speed fast enough to scoop up the tenuous atmosphere in sufficient volume to extract tons of lox.

Weighing over 500,000 pounds at take-off, the Space Plane will already be twice the launching weight of an Atlas. Then, in the stratosphere, it will gather enough liquid oxygen to double its ground weight to an amazing 1,000,000 pounds.

Now, burning this sky-harvested lox with its main tank of liquid hydrogen fuel, the 500-ton rocketcraft can soar into space. Since it takes eight pounds of oxygen to burn one pound of hydrogen, the lox can ignite a total fuel load of 60,000 pounds, furnishing enough power to achieve almost any desired orbit around the earth, or even to take a trajectory that will circle the moon once and return.

The USAF estimates a \$20 million engineering study of this exotic space-flight concept should establish its feasibility before the end of 1961. How much R&D (Research and Development) funding will later be required to produce hardware is not stated, but a USAF timetable schedules an operational Space Plane by 1966-68, if given high priority.

Some critics have doubted the human hand could control a rocketplane more powerful than a dozen X-15s in the strange environment of space. Then the USAF revealed a study made by the non-profit Rand Corporation, which conducts definitive astro-researches. By the use of simulated space cabins and controls, these tests proved that USAF jet pilots could quickly learn to handle rocket-thrusts with the finesse and skill required for steering the super-craft through space. On the basis of this study, the USAF is designing the complete

(continued on page 42)

New monitors for Astro-Science

INDEXED BY P.A.L.

A NASA report on coming satellites and probes

by **HUGH DRYDEN**

Assessing the future of astronautics is the task of a prophet, a profession not recognized as an established branch of science. Knowledge of specific developments in progress, in context with past experience, gives a reasonable basis for extrapolating a few years ahead. For the more distant future, imagination, intuition, and faith are the only tools.

Our predictable future program may be roughly divided into five categories: 1) satellites for scientific study of space radiation; 2) unmanned laboratories; 3) moon missiles and interplanetary probes; 4) manned test flights; and 5) commercial applications of space systems. However, not necessarily in that order. In fact, most of them overlap in our overall time-table.

Vehicles in preparation for 1961-63 will include some 15 specialized radiation-sensing satellites for advanced

measurements of the ionosphere, gamma and cosmic rays, Van Allen Belts, and solar radiation. Three large space laboratories are planned. The space probes include one or two lunar orbiters and two or three probes to study interplanetary plasma and electric and magnetic fields, perhaps in the vicinity of Mars and Venus. Sub-orbit and orbital flights in the Mercury Program will also occur.

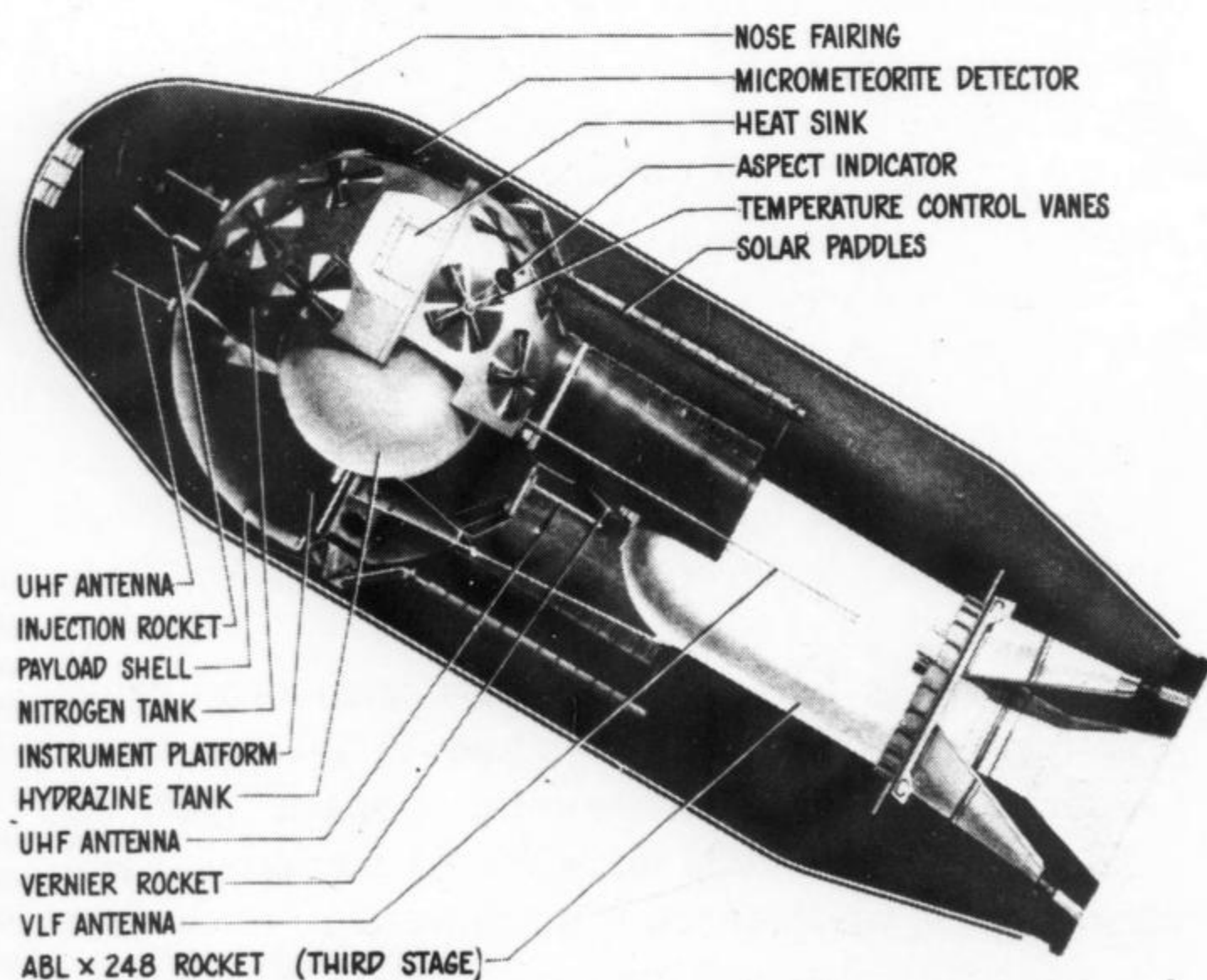
I — Space Radiations

The radiation-study satellite series will help us to understand the nature of the control exerted by the sun over events on earth, and the effects of interstellar rays. This is vital because solar phenomena affect every aspect of human activity. If our sun's radiation was to increase or decrease by a small fraction, we would perish in worldwide fire or an ice age. Thus, knowledge of the sun's influence on earth has direct bearing on our very existence, as well as our daily lives.

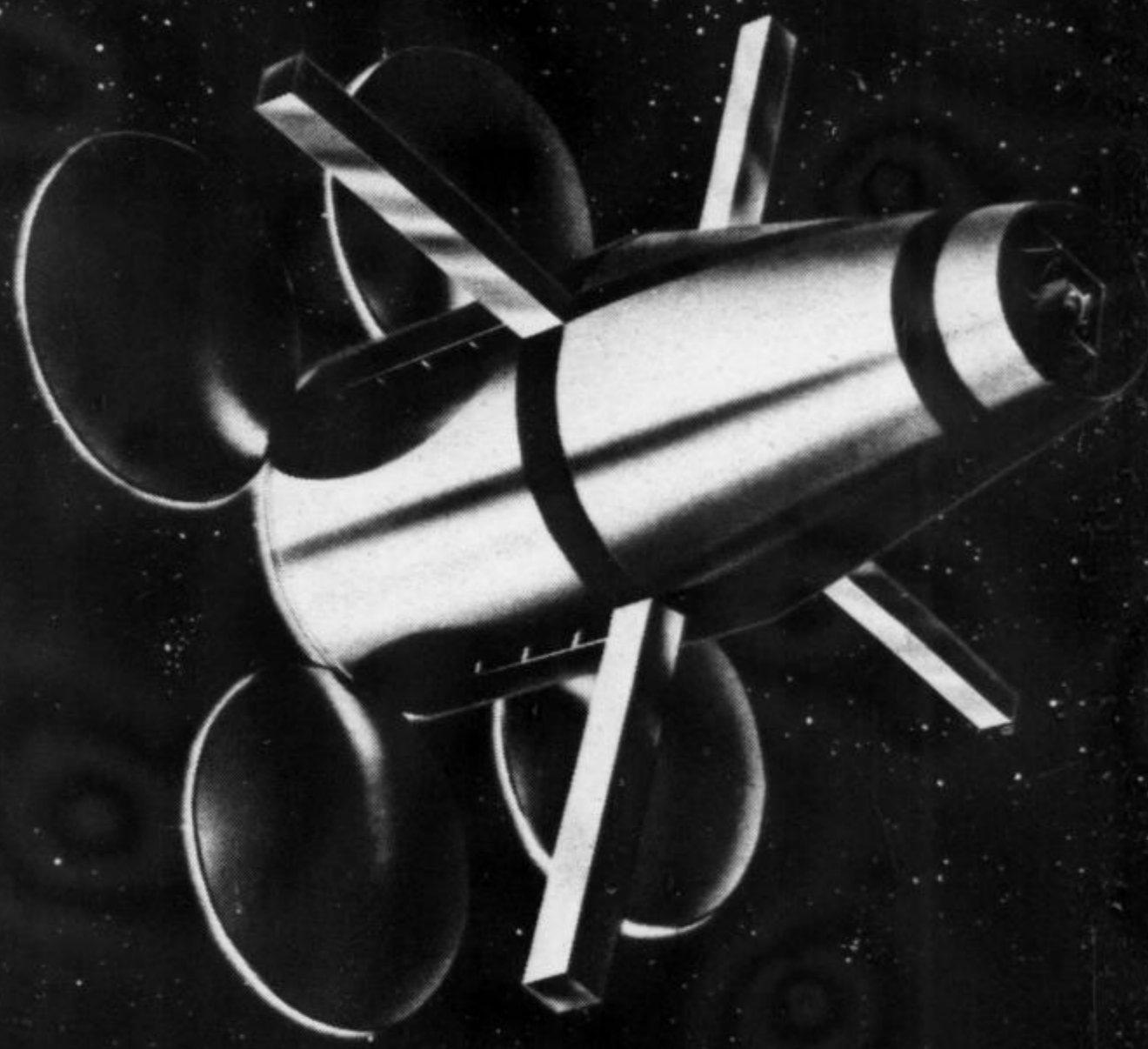
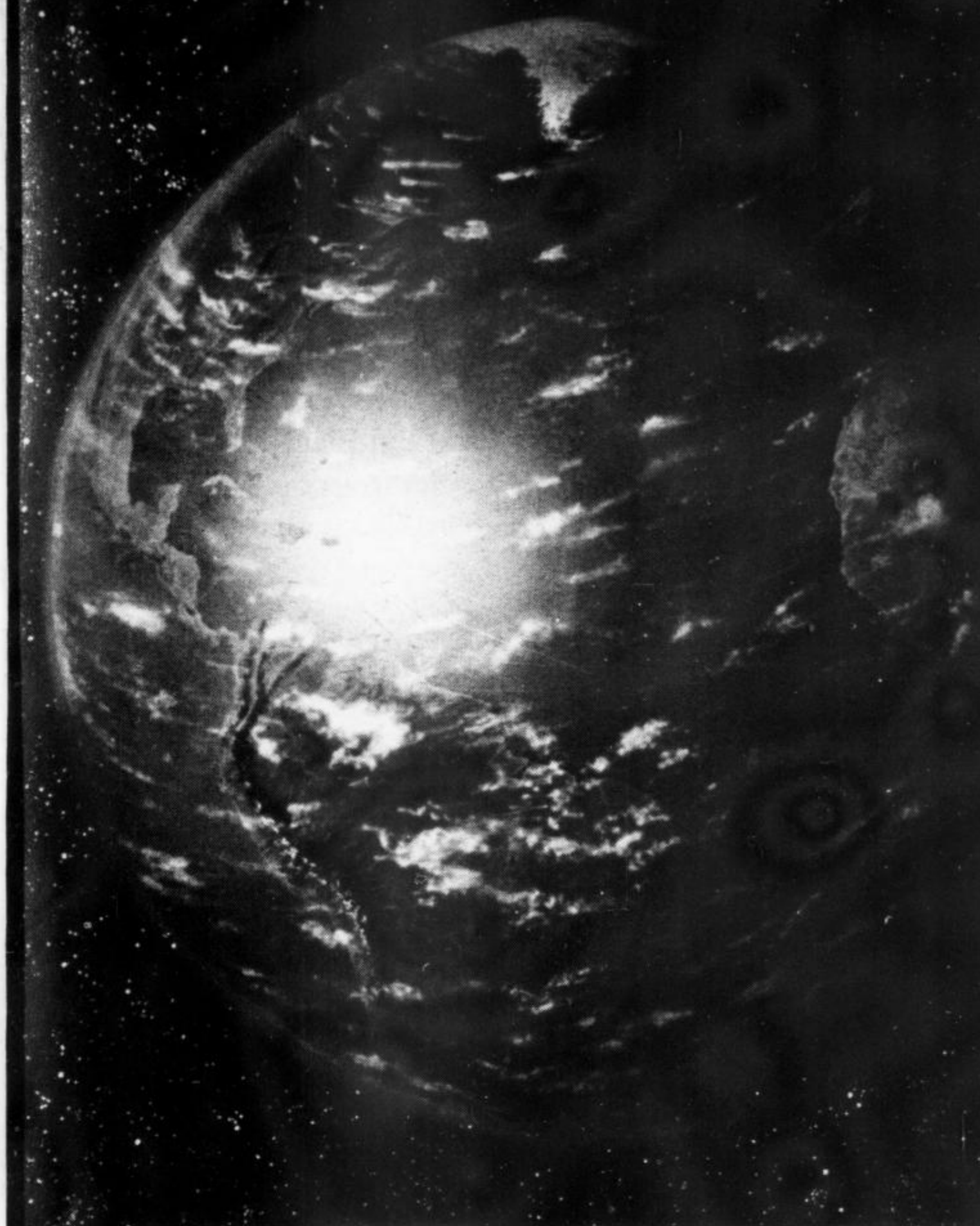
Actually, we know that the total solar energy output does not change appreciably through a period of time. It is for this reason that the solar energy reaching the earth's surface per square centimeter per minute is called the solar constant. This energy, in the visible and infrared regions of the spectrum, furnishes the driving power for our winds, storms and other weather manifestations.

But part of the sun's radiant energy does fluctuate. This includes gusts of X-rays, ultraviolet light and charged particles resulting from unusual surface turbulences on the sun. The resulting radiations travel at the speed of light, reaching the earth some eight minutes later. Absorbed in the higher levels of the atmosphere, they produce heating, chemical reactions and electrical charging of the thin ionosphere, all of which are profound weather-altering factors.

Charged solar particles that are heavier travel at a more modest 1,000 miles per second, reaching the earth in one or two days. Upon arrival, they are seized by



MOON PROBE. This cut-away drawing shows the third stage of Atlas-Able with payload that was designed for Lunar orbit.



ORBITAL TELESCOPE. Orbiting above earth's distorting atmosphere, this satellite will open new vistas in astronomy.

the earth's magnetic field and funneled into the polar latitudes, producing magnetic storms, augmenting the auroral displays, and causing serious radio blackouts and transatlantic telephonic breakdowns.

One of the most exciting space-age discoveries was the existence of the Van Allen radiation belts. These consist of trapped ions guided by magnetic lines of force into large zones, many thousands of miles above earth's surface.

Experimental evidence obtained during 1959 shows some significant effects of these belts on sun-earth relationships. Pioneer IV, launched after five days of unusually intense solar and auroral activity, detected a population of belt particles some ten times greater than that observed by Pioneer III during a period of solar quiet.

Such fragmentary measurements obtained to date have led to strong disagreements among scientists concerning true interpretation of the data. Consequently, it is important to measure variations of these energetic particles over long periods of time and far from earth. Explorer VIII is now carrying on this work with complex detectors that separate the particles by type and energy.

These scientific investigations will have a practical aspect. We may find, for example, that the arrival of large numbers of solar particles may trigger major

weather disturbances. On February 10, 1959, a large solar flare was followed by magnetic storms, radio disturbances, an immense red aurora, record high temperatures in the Arctic, and freezing snow throughout large areas of the South. Tree rings and the wheat price index both show an 11-year cyclic weather variation, corresponding to the sunspot activity cycle, whose time-pattern automatically affects our ionosphere. More knowledge of such phenomena could lead to predictions of the arrival of massed solar particles in time to light the smudge pots in Florida and save its citrus crops from a sudden freeze.

II — Unmanned Laboratories

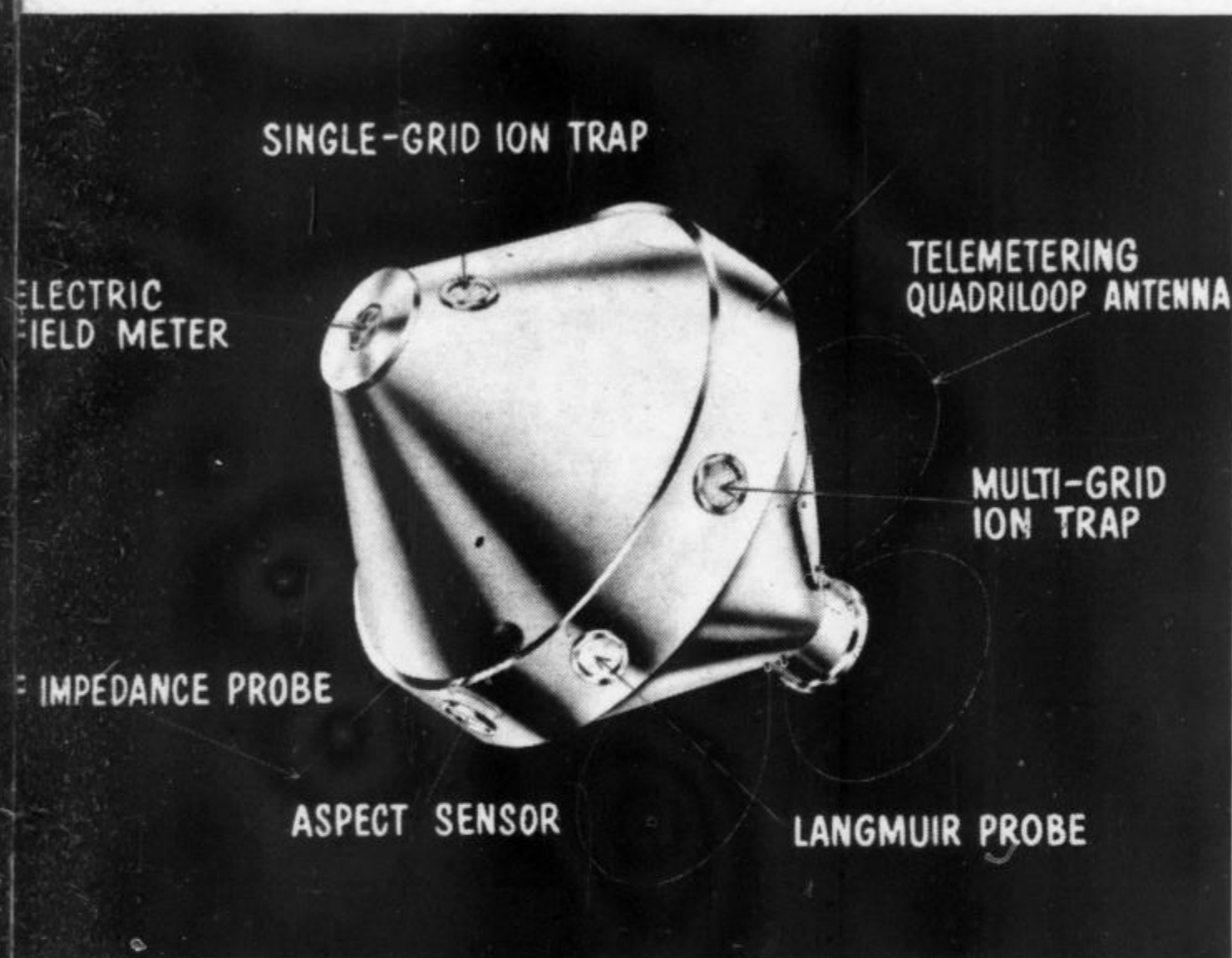
More ambitious vehicles will include an orbiting solar observatory, scheduled for launching in the first quarter of 1961. It will make spectrophotometric studies of solar radiation. The 350-pound OSO is to have a nearly circular orbit at an altitude of 300 miles.

The OSO satellite consists of a base section and extended arms for gyroscopic spin stabilization plus solar cells to charge nickel-cadmium batteries.

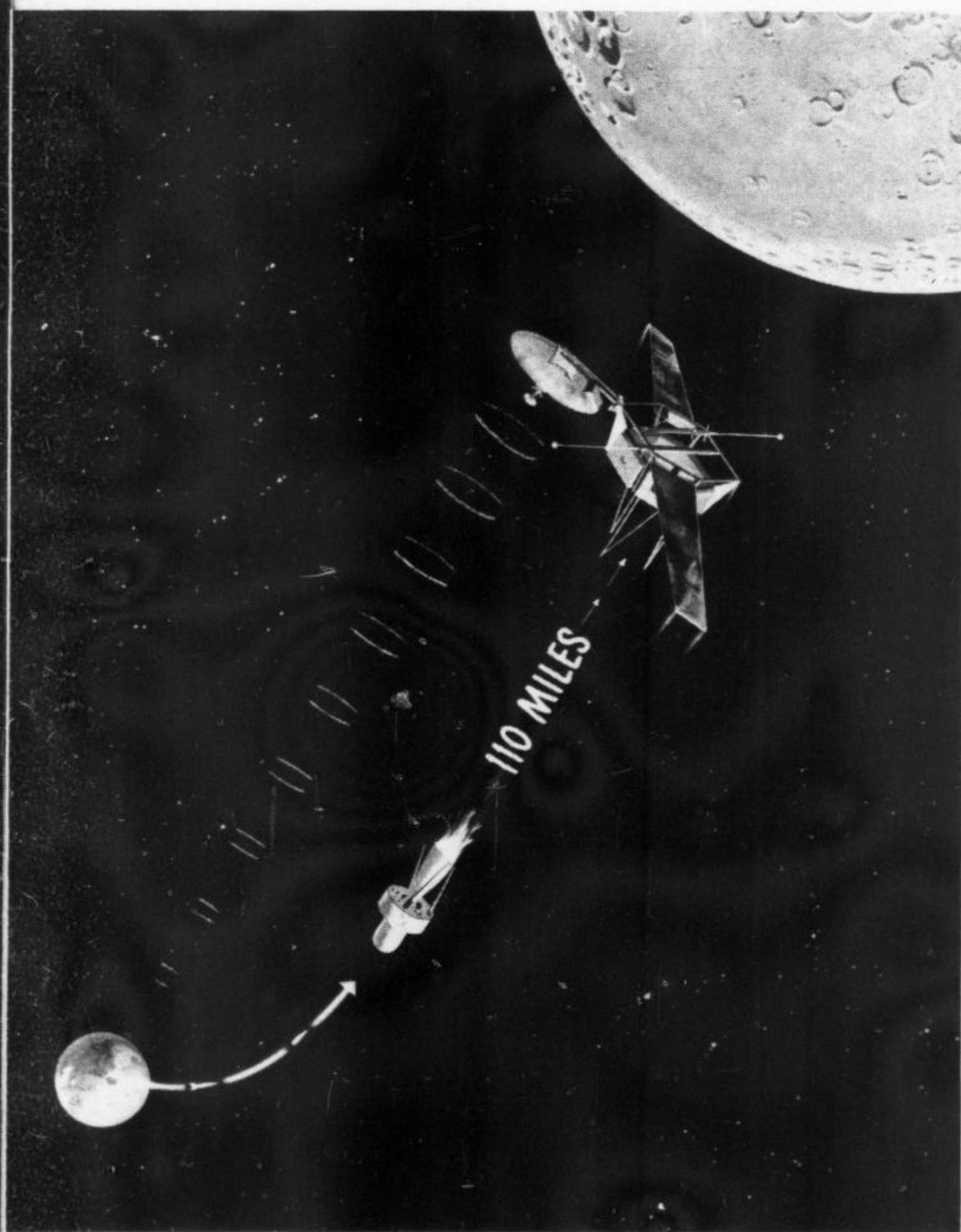
With the increase in launch capacity, large spacecraft with great flexibility can carry forward the program in geophysics. By 1963, the Atlas-Agena B launch vehicle will place an Orbiting Geophysical Observatory weighing 1,300 pounds in a nearly circular polar orbit some

(continued on next page)

These satellites will measure earth's environment



IONOSPHERE PROBE. The S-30 is designed to make direct ionospheric measurements from elliptic orbit of 200' to 800 miles.



ATLAS-AGENA LUNAR PROBE. Scheduled for late 1961, this probe, equipped with surface testers, will impact on moon.

350 miles up. Or we may decide on a highly eccentric orbit with perigee 150 miles and apogee 70,000 miles at an inclination of 33° to the equator. The present concept envisages this OGO as a cylindrical structure with large paddles for mounting solar cells.

1963 may see the first Orbiting Astronomical Observatory launch. The OAO is to weigh about 3,500 pounds and will be lofted by an Atlas-Agena B in a 550-mile circular orbit. Its principal experiments will relate to stars and nebulae in the ultraviolet range of the electromagnetic spectrum.

For the first time, man can hope to solve a mystery as to sources of ultraviolet light where there is no celestial object visible to the telescope. Any clue to this riddle from the OAO may produce new information concerning the primary structure of the universe.

Just as condensation of interstellar matter may have formed stars, so planets may have condensed out of pockets of matter left over from our sun's formation. If this condensation theory is correct, then planets similar to ours must be very commonplace in the universe. On the other hand, our solar system may have been born catastrophically, in a collision between our sun and a second star. Since such collisions would be rare among the existing stellar population, the catastrophic theory implies the probability of few other planets like earth in the universe and a correspondingly small chance of life existing elsewhere than on earth.

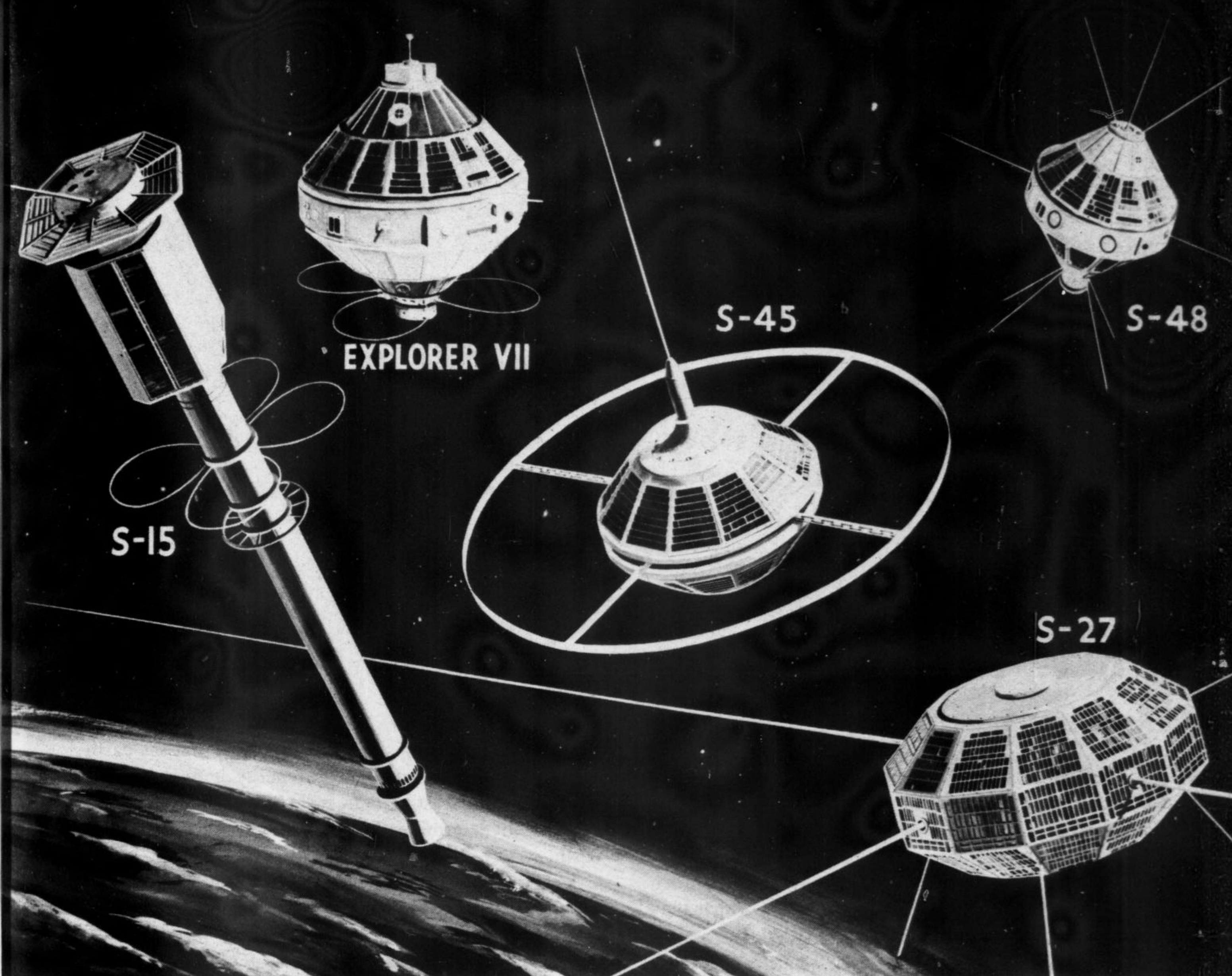
If we can determine the original temperatures of the moon and planets at the time of their formation, we can perhaps discriminate between the condensation and catastrophic theories. The moon, with its ageless untouched surfaces is of greater interest than either Mars or Venus.

III — Interplanetary Probes

For cosmological history, our first need is to read nature's handwriting on the lunar surface. Television cameras in moon orbit can radio back detailed ground-level information. Furthermore, television reconnaissance can select a location for the first soft lunar landing which will lead to much better information concerning the lunar landscapes in close-up.

A series of three lunar impact missions are scheduled for 1961-62 with a spacecraft called the Ranger, to be launched by an Atlas-Agena. The basic main section will carry guidance and control, telemetry, and propulsion equipment which will allow impact on the moon within a predetermined area. A steerable antenna is to be pointed toward the earth for communication purposes.

As part of its lunar impact mission, Ranger also car-



GODDARD MISSIONS. Here are some NASA satellites and probes scheduled for orbit in the near future: S-15, gamma ray telescope; Explorer VII, lunar orbiter S-45, a satellite to study

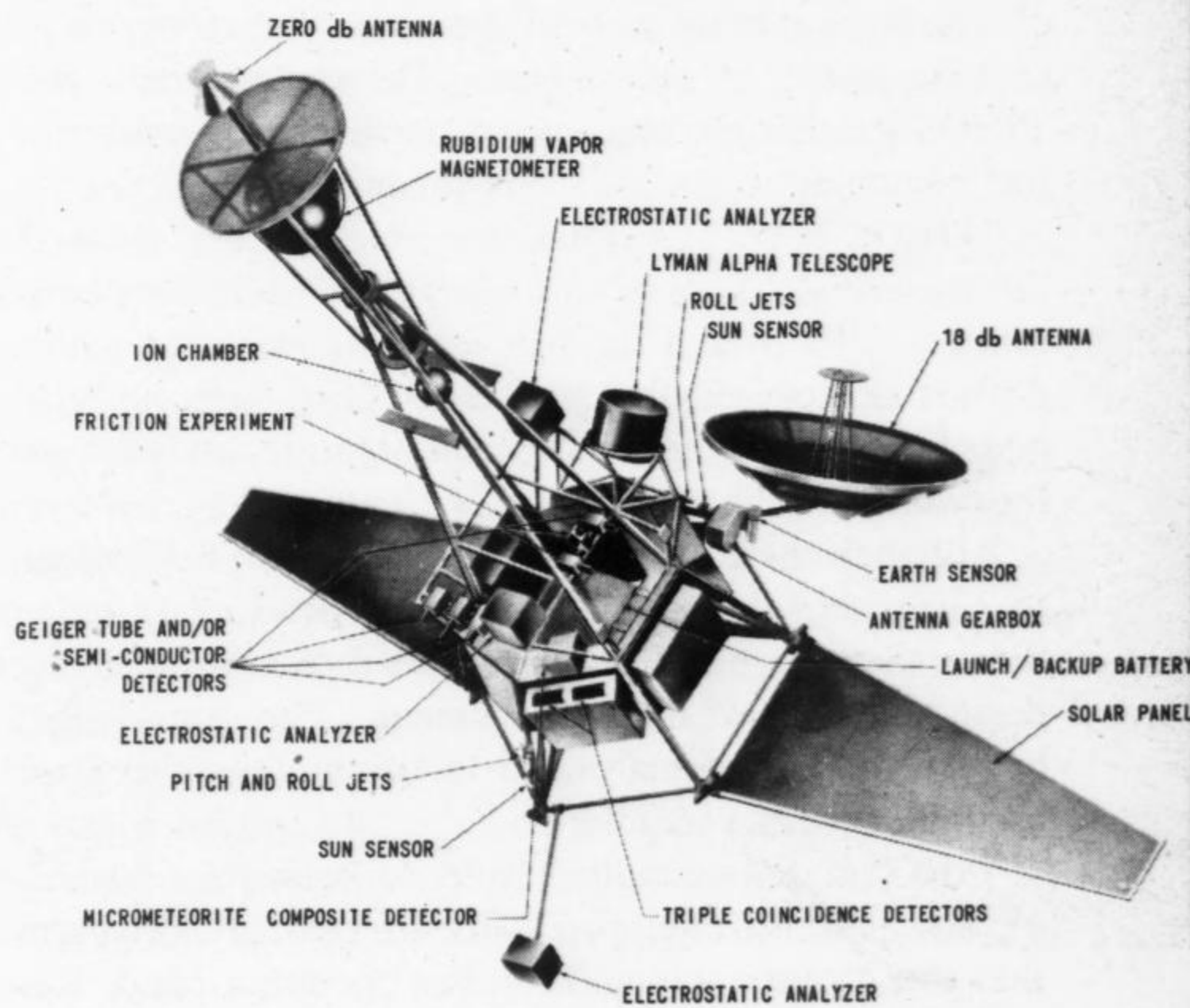
the ionosphere; S-48 and S-27, two ionospheric topside sounder satellites, the latter being prepared by Canada. Below is artist's drawing of the Ranger, designed for hard-landing on the moon.

ries a survivable capsule to be slowed by a retro-rocket for ground-contact at less than 500 ft/sec. This capsule will contain a seismometer as the primary experiment to detect lunar surface tremors from volcanic activity (if any) or from meteor falls. A television camera will transmit pictures with a resolution of ten feet during the final moments before impact.

These complex lunar missions will be preceded by several spacecraft development flights. The same basic vehicle will be used on early planetary missions to Mars or Venus. It will be modified for those longer journeys and will be called the Mariner.

One of the most exciting missions of space research is to search for life beyond earth. The discovery of living species on another planet like Mars or Venus would have tremendous implications. For one thing, our understanding of the origin of life might make gigantic strides forward if the extraterrestrial specimens are more ancient than ours.

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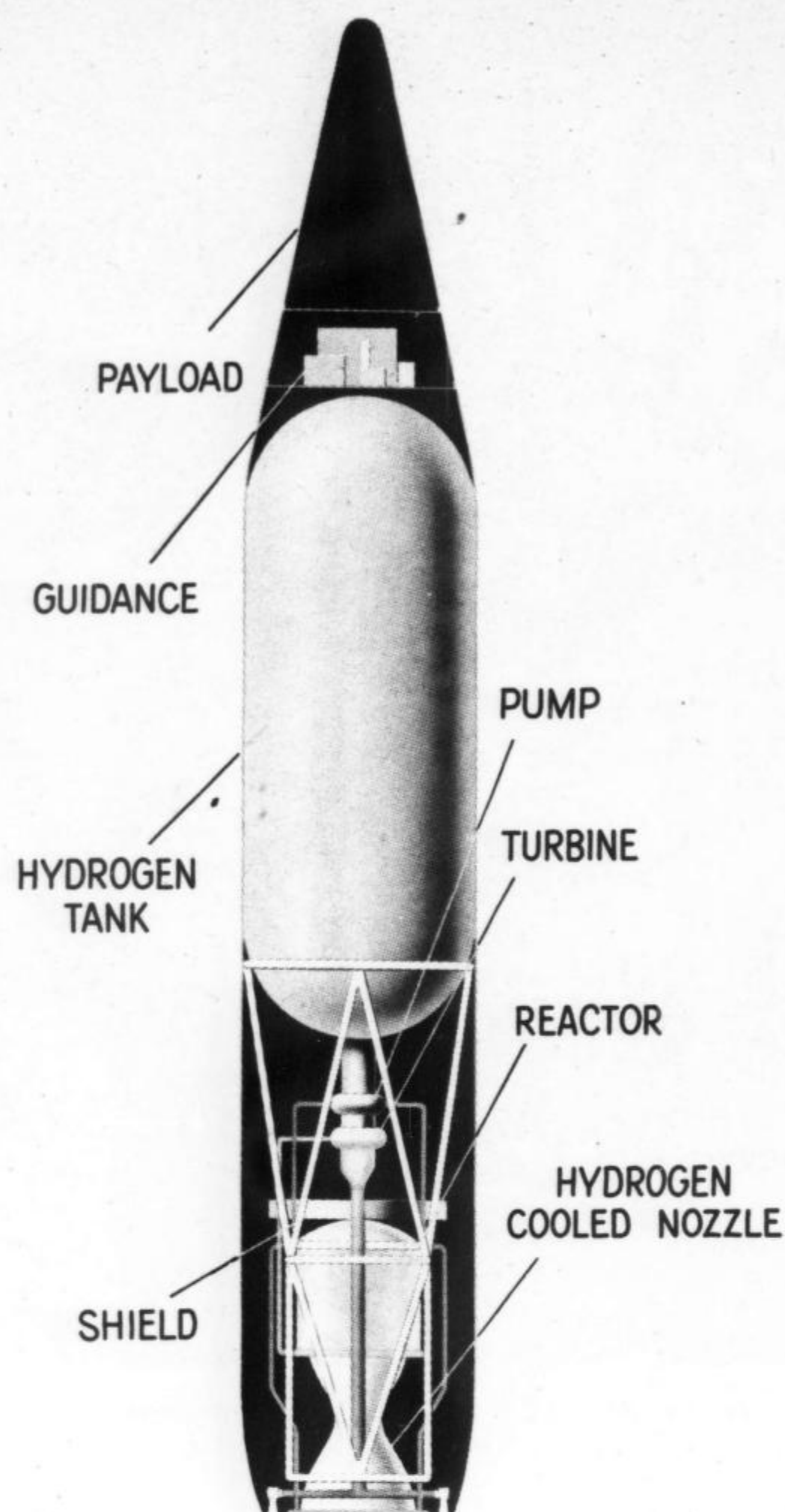


INDEXED BY P.A.L.

PROJECT ROVER

by WILLY LEY

**An authority discusses nuclear
powered rockets—the theories
and the practical applications**



The following anecdote, apocryphal as it sounds, is actual fact. When atomic energy was new and very hush-hush, a large company working in the field printed a basic manual for their own scientists and engineers. The cover page of this nuclear primer bore, in large letters, the title *UNCLEAR PHYSICS*.

There is more truth than typo in that title, at least for anyone except an atomic expert, judging by the questions I got after almost every lecture this past winter. Often I would predict what is likely to happen in astronautics during the next five or six years and afterwards somebody would ask whether chemical rockets would still be used as much as now.

My answer was "yes," for the near future only. After that, nuclear propulsion would very likely start competing strongly with chemical rockets.

The questions which then followed made me realize that the words "nuclear" and "unclear" are in truth almost synonymous to atomic neophytes. A number of people were sure to wonder why it should take a half dozen years for nuclear rockets to appear. We have atomic-powered submarines, don't we? Why not use the sub's atomic powerplant, since it exists?

Others started quoting—or so they thought—from authoritative articles about atomic spaceships written by what might be called 'unclear experts' on nuclear

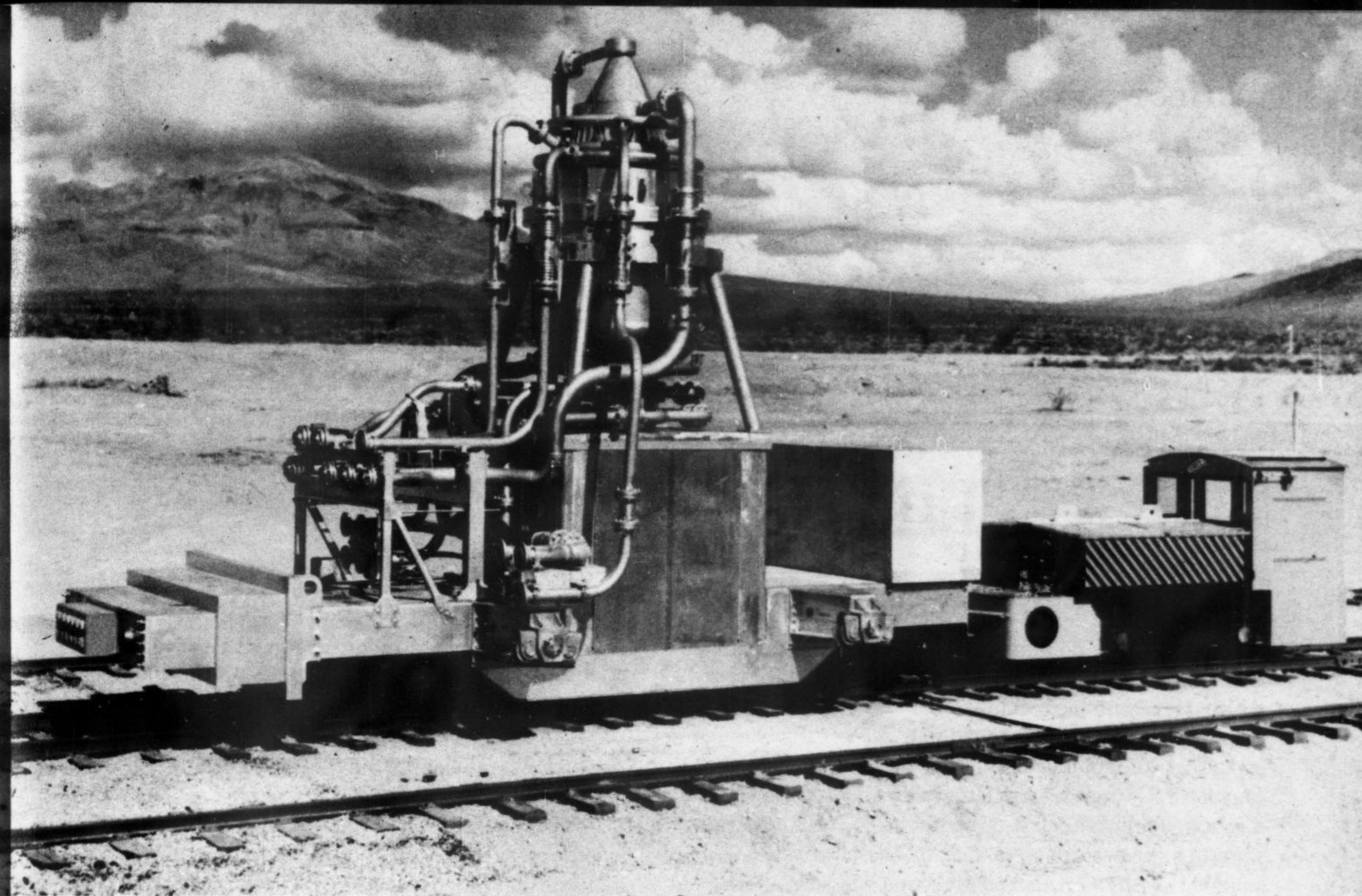
systems. As a result, many misconceptions confuse the minds of people interested in space travel.

First, it is necessary to explain what atomic propulsion for rockets is *not*. The case of the atomic submarine can be disposed of quickly by explaining its powerplant.

Basically, it is a nuclear reactor which, by the fissioning of uranium or plutonium atoms, grows hot. It is "cooled" (relatively speaking) by a liquid metal of a low melting point which also serves as a heat-carrier to the boilers. The precise metal has not been disclosed, but it might be one of the "eutectic alloys" which have lower melting points than any one of the metals composing them.

In any event, the temperature at which this metal melts is still higher than the boiling point of water. So through heat-exchange techniques, the liquid metal is piped to the boiler and boils water into steam, which in turn spins a turbine that finally drives the submarine's propeller. The steam is then condensed by exposure to cold sea water and goes back into the boiler, just as the cooled metal returns to the cooling system of the reactor. The cycle repeats itself indefinitely.

It should now be clear that the nuclear reactor is just a very highly sophisticated fire-box producing the required heat, in place of coal or oil, to keep the system going. But the end result is quite like coal/oil and the



KIWI-A REACTOR. This atomic power source is a prototype for nuclear rocket engines now under development.

actual mechanical propelling of the vessel is done by ordinary ship's screws. It goes without saying that such a propeller cannot propel a rocket in space.

The so-called atomic-powered spaceships questioners had in mind were something else entirely from true A-powered rockets: the family of "ion drive" concepts. The basic ion drive theory is to create an exhaust of electrically charged (ionized) atoms or molecules that have been accelerated to high velocity by electric fields. Now, generating these electric fields naturally takes power, as does the production of ions. Theoretically this power can come from any suitable source. One design by Dr. Ernst Stuhlinger would use solar energy. But most designers have an atomic reactor in mind as the power source. It is, of course, linguistically correct to call such a ship an "atomic powered ship", in that case. But not in other cases. The primary fact is that propulsion would come from ion blasts, whether generated by an atomic reactor or not.

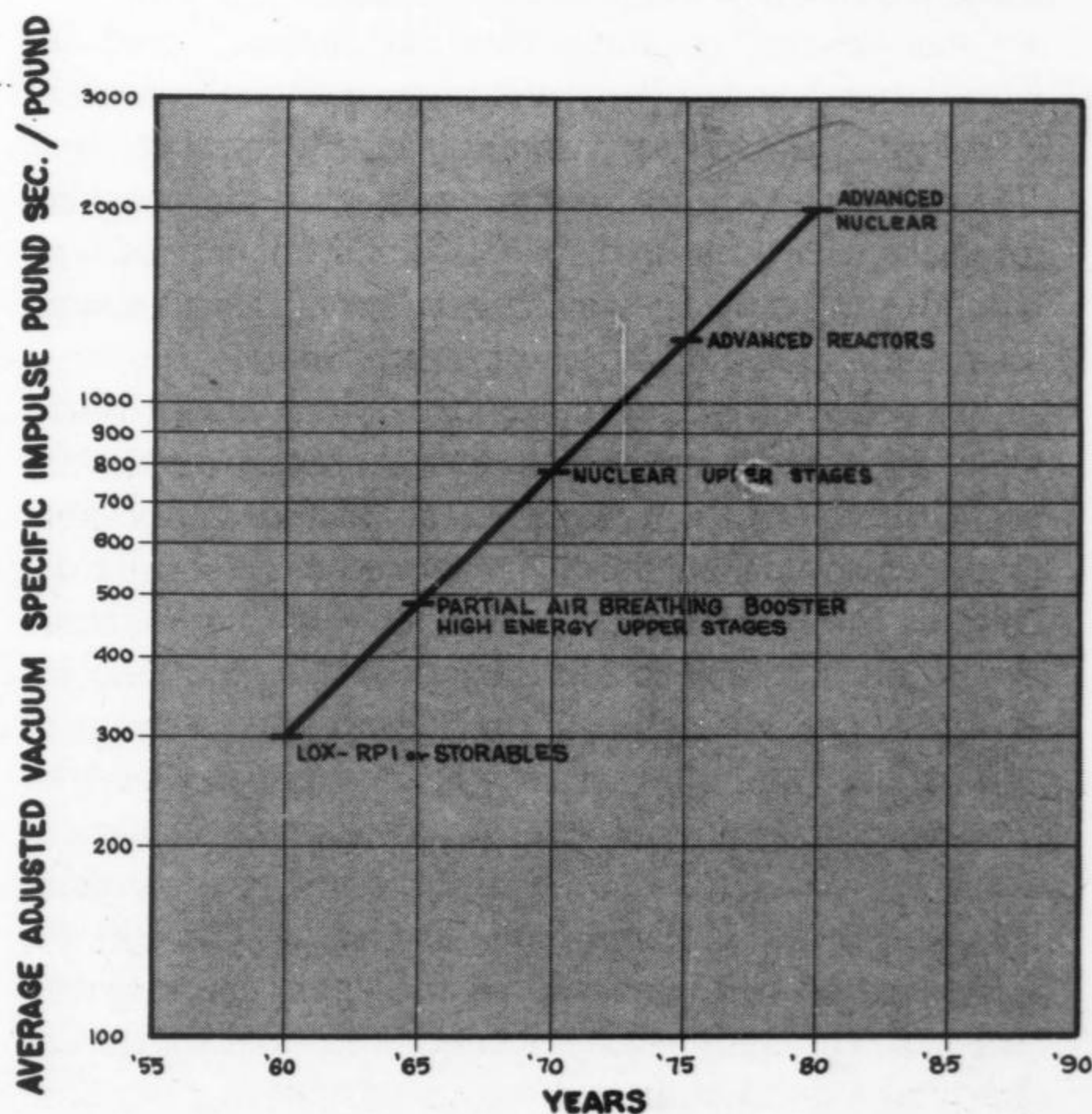
Inside The A-Rocket

True nuclear propulsion is where atomic energy moves the rocket directly and comes only from a nuclear reactor. From the outset it was clear to atomic researchers that there was only one way of doing this.

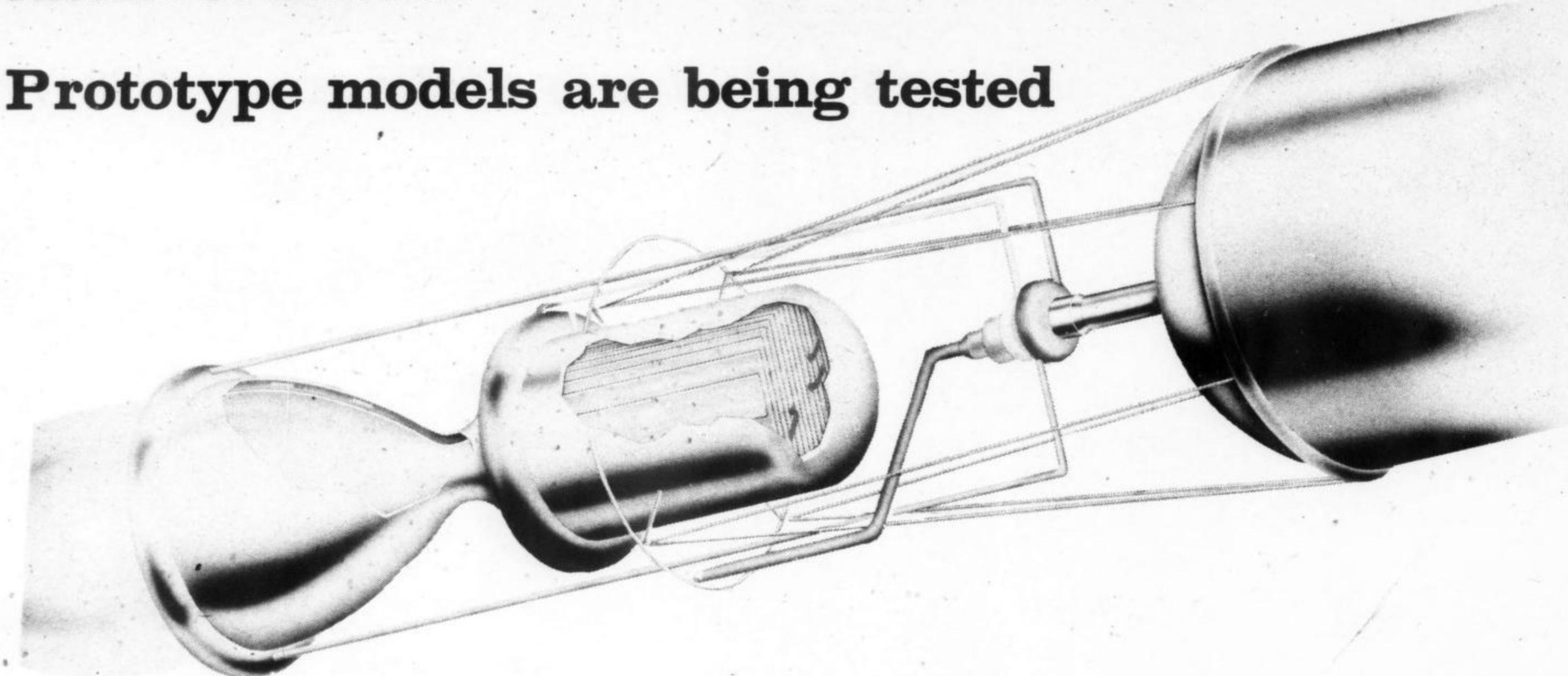
In the chemical rocket, whether liquid fuel or solid
(continued on next page)

INCREASE IN SPECIFIC IMPULSE

This graph projects the growth in rocket power potential as a result of nuclear applications.



Prototype models are being tested



fuel, the propellants first provide stored chemical energy which is released by combustion. But in addition to energy, the fuel provides something else — namely, large quantities of combustion gases to form the exhaust blast. A rocket moves by literally throwing part of itself away violently. The cast-out combustion product, composed of gases and accelerated by the chemical energy inherent in the fuel, is the “reaction mass.”

This term is somewhat unfortunate in two respects. Actually it is the rocket itself which moves by reaction so that the gaseous mass discharged through the exhaust nozzle should rightfully be called the “action mass”. There is a second possible misunderstanding in that the term “reaction mass” was coined decades before atomic chain-reactions were even dreamed of, but now it sounds as if this exhaust gas is to come from the nuclear reactor itself — which is never possible at all.

Chemical fuel (to make clear the unclear) provides *both* the energy and the reaction mass. But the nuclear reactor can provide energy *only*, in the form of heat. Therefore a separate reaction mass has to be provided for the nuclear-powered rocket. Whatever is chosen to be shot out of the exhaust nozzle is entirely unrelated to the fissioning of uranium or its by-products.

In a more distant future we may hope to use ordinary water for this RM exhaust material. If this can be accomplished, a nuclear-propelled spaceship will be able to replenish its RM on any planet where water exists. But for the time being, water has only the advantage of being cheap and is full of drawbacks otherwise, including its weight and its corrosive activity as steam.

The problem in the first atomic rocket engines will be to transfer the energy from reactor to reaction mass at the highest BTU rate and in the shortest possible time. The lighter the RM molecule, the easier this will be. For this reason, the earliest investigators chose hydrogen gas. The hydrogen molecule (it normally exists as 2 bound atoms) is the lightest in existence.

Oddly enough, hydrogen is one of the most powerful

of chemical fuels, and a hydrogen-fueled upper-stage Centaur is under active development. But the fact that hydrogen can be an excellent chemical fuel does not count at all when used for nuclear propulsion, where it is not burned with oxygen and is only used by itself as the expelled RM.

Hydrogen Power

Why hydrogen has value in nuclear propulsion, without being burned as a fuel, was explained in an early publication, “The Problem of Escape From The Earth by Rocket” by Frank J. Malina and Martin Summerfield (*Journal of the Aeronautical Sciences*, Vol. XIV, No. 8, August 1947). Values are given for various chemical fuels as well as for hydrogen heated by an atomic reactor.

I — CHEMICAL FUELS

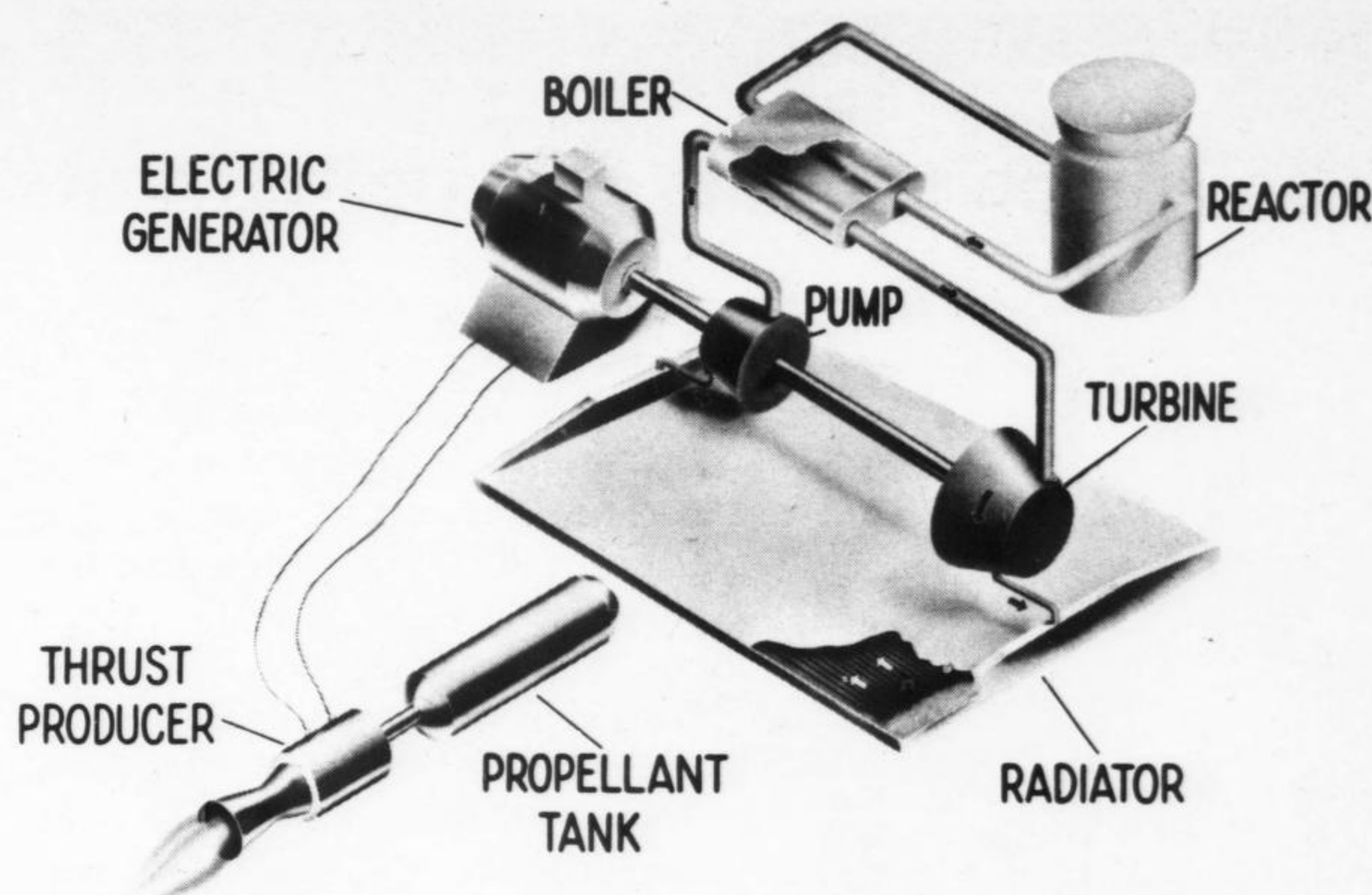
Combustion Temperature (Fahrenheit)	Exhaust Velocity at sea level (Feet per sec.)
Nitric acid + aniline = 5070°	6200
Hydrogen peroxide (H ₂ O ₂) + methyl alcohol = 4160°	6300
Oxygen + ethyl alcohol = 5260°	6870
Oxygen + Hydrogen = 4390°	10,150

II — HEATED HYDROGEN

Reactor Temperature	5,000°	7,000°	9,000°	11,000°
Exhaust Velocity	23,400	29,100	36,400	42,300

It can be seen that with not much increase in the atomic chamber's temperature, the exhaust velocity more than doubles (Part II) compared to hydrogen burned as a chemical fuel with oxygen (Part I). However, doubling the exhaust velocity does *not* automatically double the thrust, since this is influenced by the *weight* of the exhaust molecules too. Hydrogen by itself

UPPER STAGE. Nuclear rocket, left, will first be used as an upper stage of a chemical-fueled rocket. Reactor (see cutaway) will heat hydrogen gas before it is expelled through thrust chamber. Another nuclear propulsion system, right, uses reactor heat to operate an electric generator. The electricity is then used to ionize a stream of plasma which provides thrust to rocket.



weighs much less than the combustion product of burned hydrogen, which is water. Yet all things being equal, there is a gain in thrust with H_2 gas, through higher exhaust velocity.

To utilize hydrogen/RM to the fullest, the main engineering factor is to heat the gas rapidly by running the nuclear reactor very hot. The problem then is efficient cooling so that the reactor isn't damaged or melted and keeps working. This is solvable through regenerative cooling by the hydrogen (in low-temperature liquid form) which is heated in the process, before it is cycled through the reactor as the RM blast.

The hydrogen/RM emerging from the exhaust nozzle at a temperature of several thousand degrees Fahrenheit will then, of course, ignite with oxygen while the rocket is within the atmosphere. This does not, however, contribute one iota to the propulsion. It is merely a side effect which is bound to take place and need not be prevented. At altitudes above atmospheric oxygen, no ignition of the exhaust would take place and the expelled hydrogen gas would simply dissipate in its elemental form. It is only when exhausting from the nozzle that H_2 /RM does its work. That is the primary motive power of the atomic rocket.

A rocket using such liquid hydrogen as a reaction mass, in conjunction with a nuclear reactor, is the goal of Project Rover, now a joint project of NASA and AEC. Originally, Project Rover was conducted by the AEC in cooperation with the U.S. Air Force back in 1956/57. The USAF then switched to Project Orion, in which other atomic engine concepts of a more exotic nature are being investigated.

At first Project Rover suffered from the disease common to all scientific projects at the time—it was artificially starved by a tight-fisted and thoroughly unimaginative Bureau of the Budget. Rover feasibility studies virtually died of monetary malnutrition. But after Sputnik II in November 1957, the Administration lamely yielded to public and Congressional pressure, and the

Budget Bureau released \$15 million which had been appropriated more than a year before. These \$15 million were used for the construction of test facilities.

Grounded Giant

All along, the nuclear rocket program has been subdivided into four phases, the first named Kiwi. Since the Kiwi in nature is an absolutely flightless bird (native habitat: New Zealand) this name graphically pointed out that the first prototype would not attempt flight. Nor will the second phase leave the ground. The third phase's hardware will probably fly, but only the fourth phase is expected to be the "real" atom-powered rocket.

In sharp and welcome contrast to the Mercury Project's clockwork slippages, Project Rover's target date was originally set vaguely for the 1970s, then was pulled down to 1968, to 1966 and recently to 1965. NASA has selected Lockheed and Martin as prime contractors to devise engineering methods and hardware for the nuclear flight tests, with Rocketdyne and North American as sub-prime contractors. No NASA venture before has gone into such a headlong pace, based on major breakthroughs in the application of atomic energy to space vehicle propulsion.

Project Rover's history is incredibly short. Feasibility study began in 1956. Tests with the first Kiwi device have already been run (in 1959) at a Nevada site.

No details about the design and performance of Kiwi-A were released except the statement that everybody was pleased. In the summer of 1960, tests with the second device, Kiwi-A-Prime, were run. The Rover people now grinned like the Cheshire cat. But still nothing was released, so that no outsider could tell how Kiwi-A-Prime differed from Kiwi-A. But it was made known that Kiwi-A-Prime ran (after several hours "warm-up" of the reactor) for a total of 15 minutes, five minutes at full power. The hydrogen RM expulsion was started before the reactor was brought up to power and the gas was ignited so that combustion would turn

(continued on page 54)

LUNAR COLONY

**Establishing a manned base on the moon
poses some unique problems of survival**

by **OTTO O. BINDER**

A growing body of scientific opinion foresees transportation costs falling low enough to make large-scale interplanetary travel economical by about 1975, certainly by 1980. Using nuclear power, mammoth spaceships of 50,000 tons or more will cut shipping costs down between \$1.00 and \$2.00 a pound for the moon, under \$10.00 a pound to Mars and Venus, \$15 a pound to the asteroids, and \$25 a pound to Jupiter.

In the next decade, even with earlier and smaller ships, the moon rate will fall to \$10 a pound and make possible lunar colonization soon after the first pioneering outposts are established.

"The major problem associated with living on the moon," points out Dandridge Cole, a space systems specialist in the aerospace industry, "is the lack of a breathable atmosphere. However, this is not as serious as it first appears. Nuclear submarines have stayed under water for more than 2 months at a time and could stay under considerably longer if necessary. The Martin Company is working on the problem and has designed

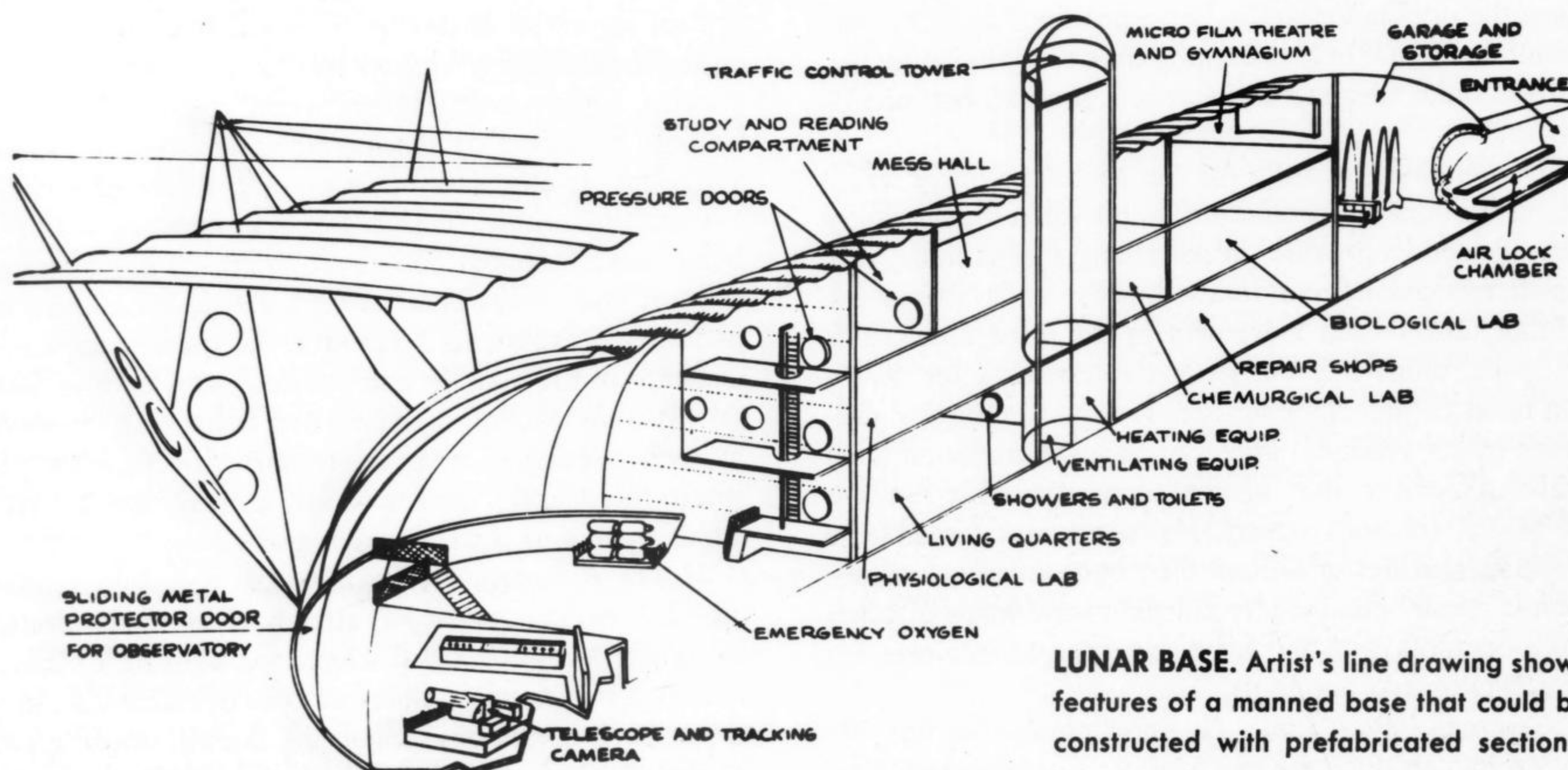
a Lunar Housing Simulator. When built, men will live and work in it for periods of a month or more under moon-like conditions."

Included in the Martin Moon Colony is a complete ecological system for recycling drinking water, purifying and re-using air, and growing crops through hydroponic methods. If these three basics of air, water and food are assured, the rest is comparative child's play in the conquest of Luna.

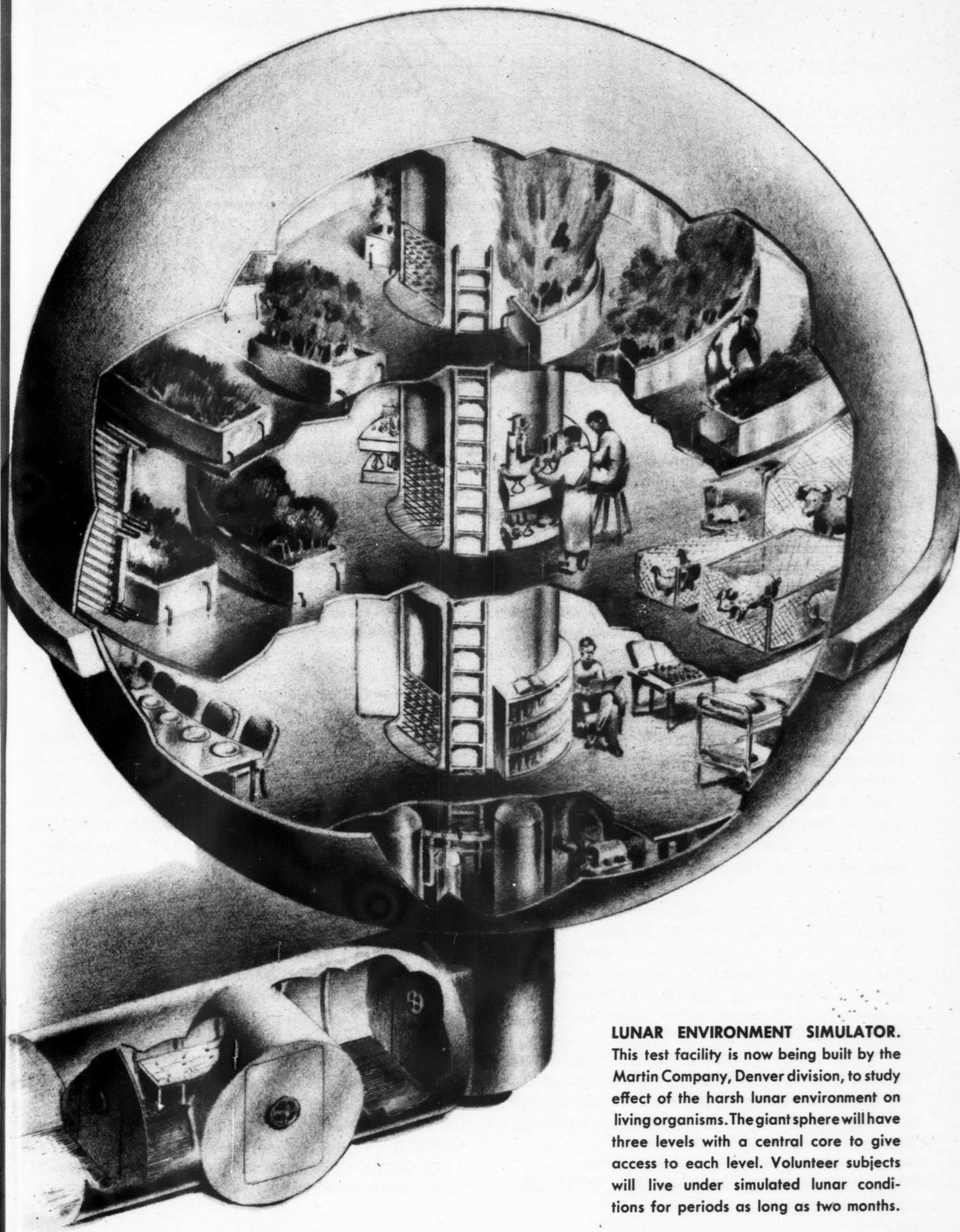
In a permanent lunar base, food is considered the least difficult of the three problems, not only by Martin but by other aerospace firms researching future other-world communities.

For over a year, Republic Aviation has been growing its well-known Moon Garden under sealed-off non-earthly conditions and reports that such crops as snap beans, carrots and turnips can undoubtedly be grown in a lunar hothouse under low-pressure air. They can even be grown faster. The sun's intense actinic rays, unfiltered by a lunar atmosphere, will increase photosynthesis and make plants grow at fantastic rates, just as hot climates on earth produce two and three crops a

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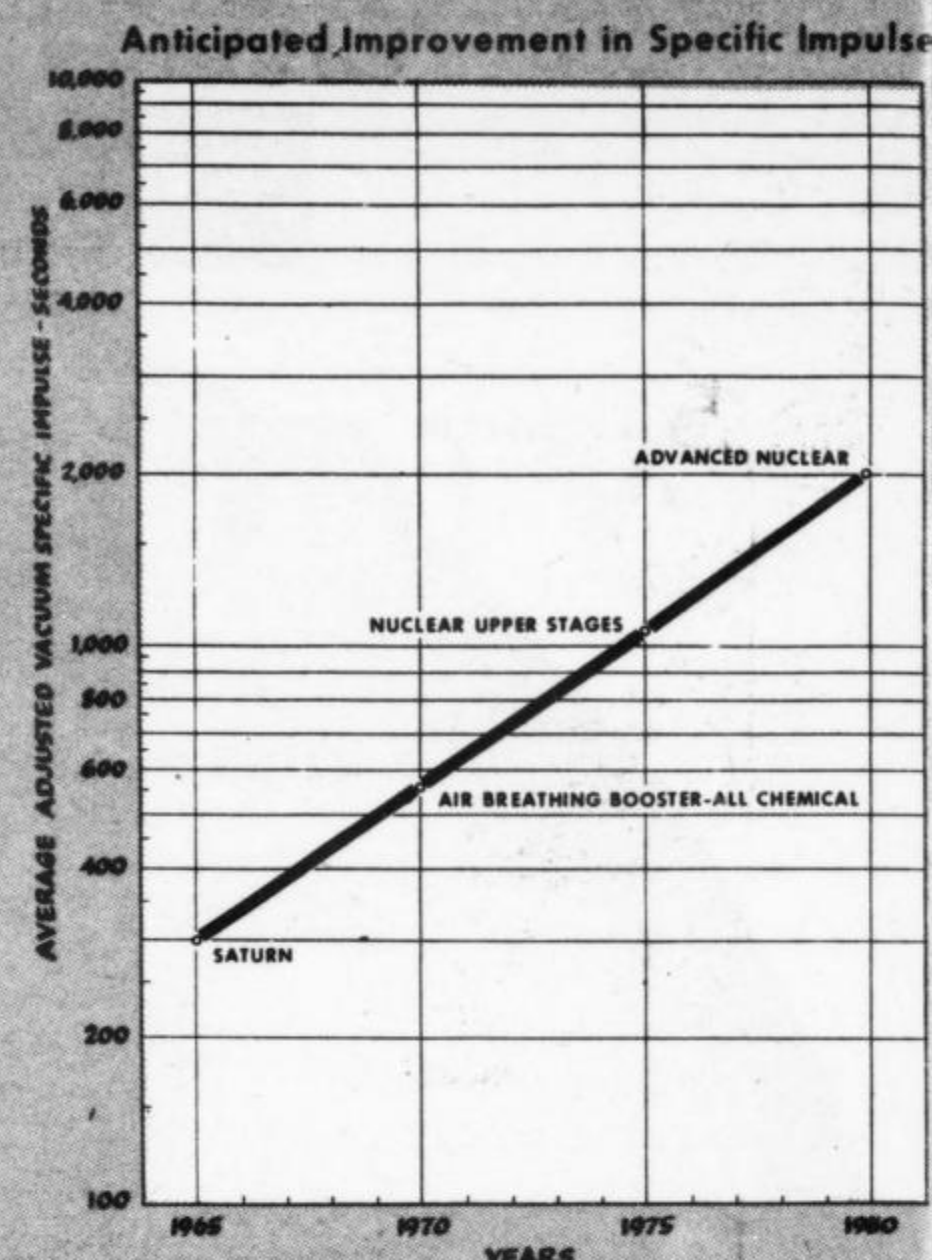
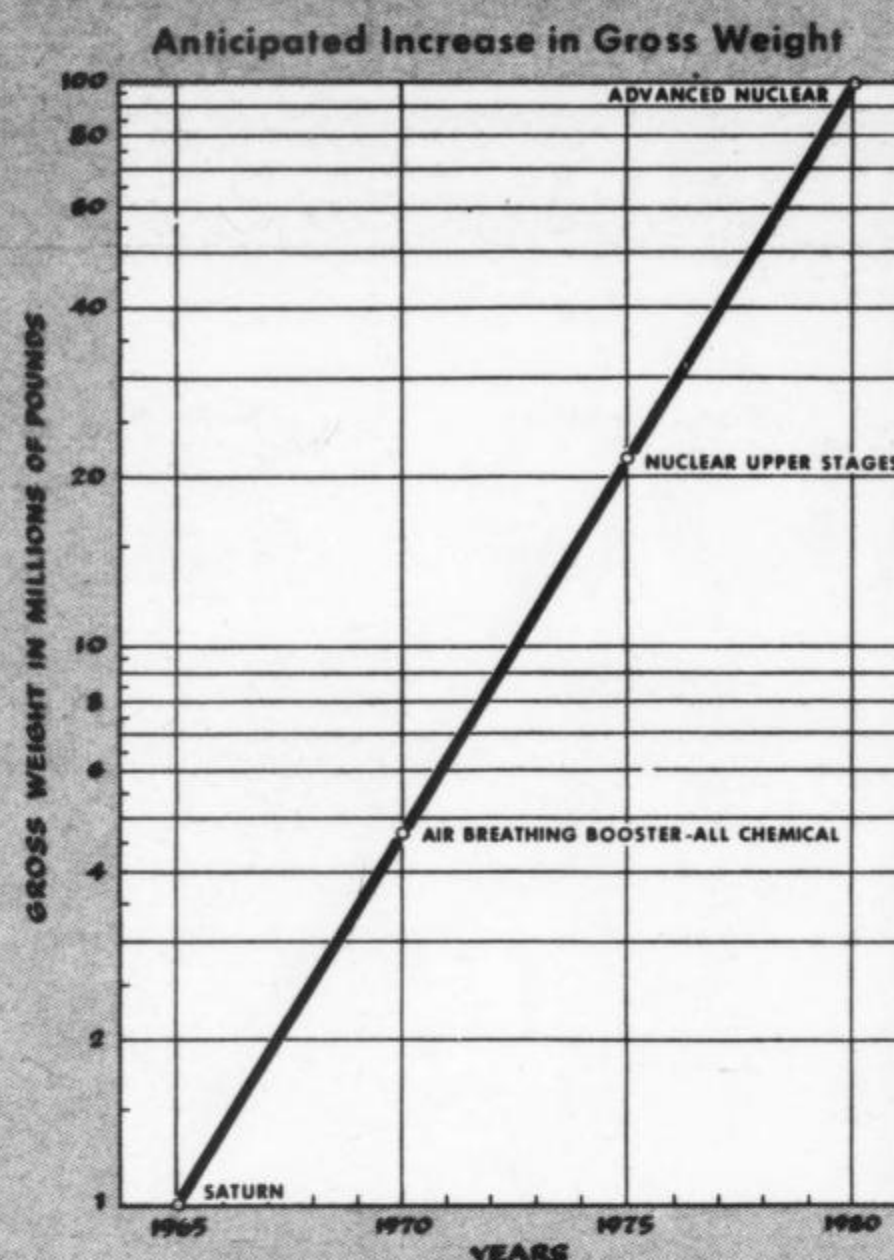
LUNAR BASE. Artist's line drawing shows features of a manned base that could be constructed with prefabricated sections.



LUNAR ENVIRONMENT SIMULATOR. This test facility is now being built by the Martin Company, Denver division, to study effect of the harsh lunar environment on living organisms. The giant sphere will have three levels with a central core to give access to each level. Volunteer subjects will live under simulated lunar conditions for periods as long as two months.

Performance Projections

These graphs project anticipated improvement in rocket performance and reduced cost for lunar transportation within the next twenty years. This development will make possible the establishment of a manned base on the lunar surface.



year under abundant sunshine. Compact hydroponic plant-food chemicals plus water can be easily supplied to sustain this high-speed growth.

Obtaining water for the colony, upon close analysis, is not the barrier it seems either. Owing to a peculiarity of human metabolism, a good portion of the solid foods we eat is chemically converted into water vapor along with carbon dioxide, both of which gaseous by-products are expelled by the lungs. Each person daily produces an *extra* half pint of water out of his dry-weight food. Hence, people themselves become a "chemical factory" producing new water supplies which their lungs pump into the air around them. It's no trick to condense this water vapor and distill it for drinking and washing purposes.

Furthermore, astronomers conjecture that in the depths of sunless craters there may be deposits of indigenous hoar frost or ice, frozen ages ago and never evaporated into space along with the rest of the original lunar atmosphere. This can be thawed out into usable water.

Thirdly, many minerals and rocks on earth contain loosely bound water which can be freed by heating. It is highly probable that when the moon and inner planets cooled from a molten state ages ago, they all formed a similar family of crystal rock-minerals. Lunar minerals must therefore include water-bearing types similar to earth's.

If water is available on the moon, then air, the toughest Bio Barrier, is automatically shattered. Electrolysis of water yields life-giving oxygen, along with hydrogen.

The by-product hydrogen, in turn, can be burned to produce electricity by the new fuel-cell technique now being developed. Thus, starting with electricity supplied by a common solar-heat steam generator, the breakdown

of water in quantity can then provide the constant fuel needed to make the process self-sustaining.

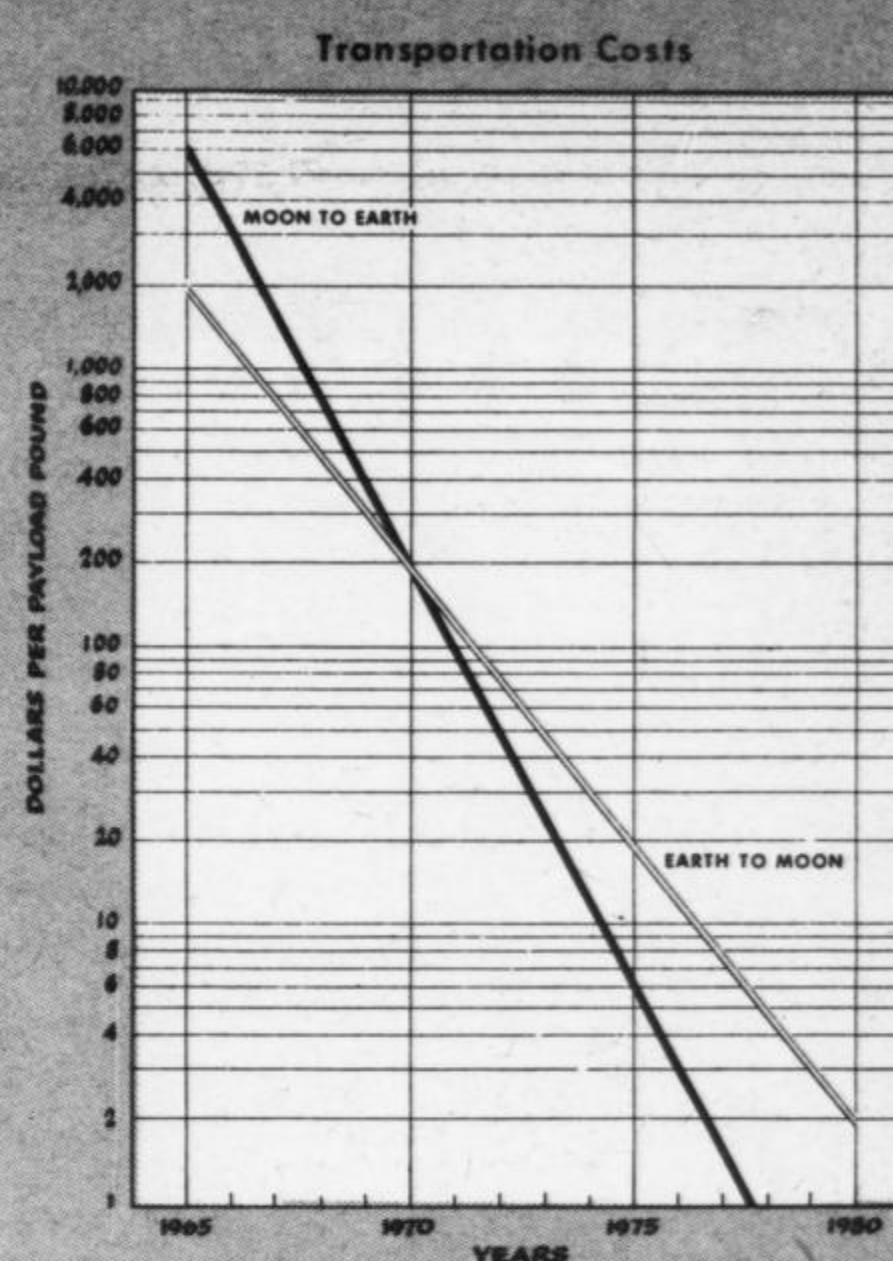
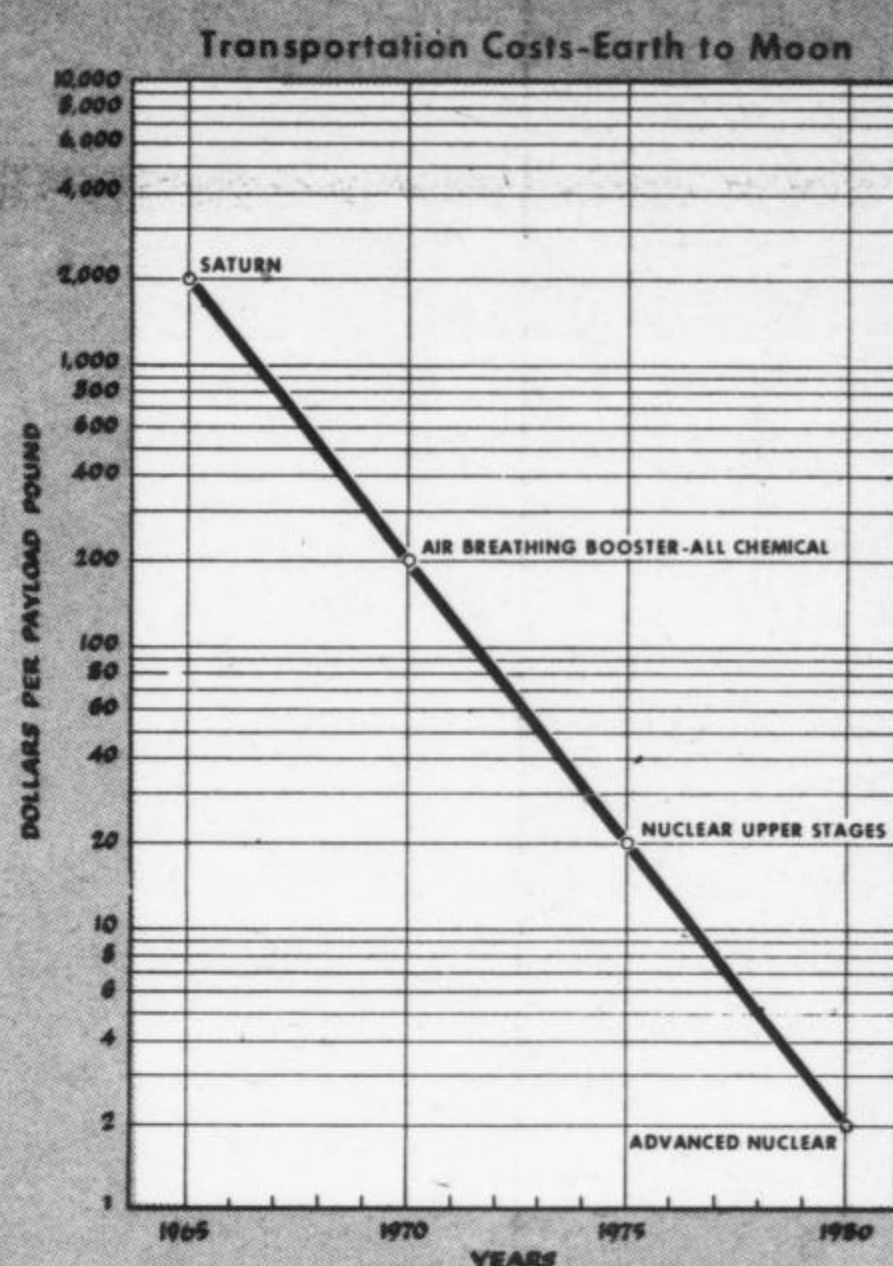
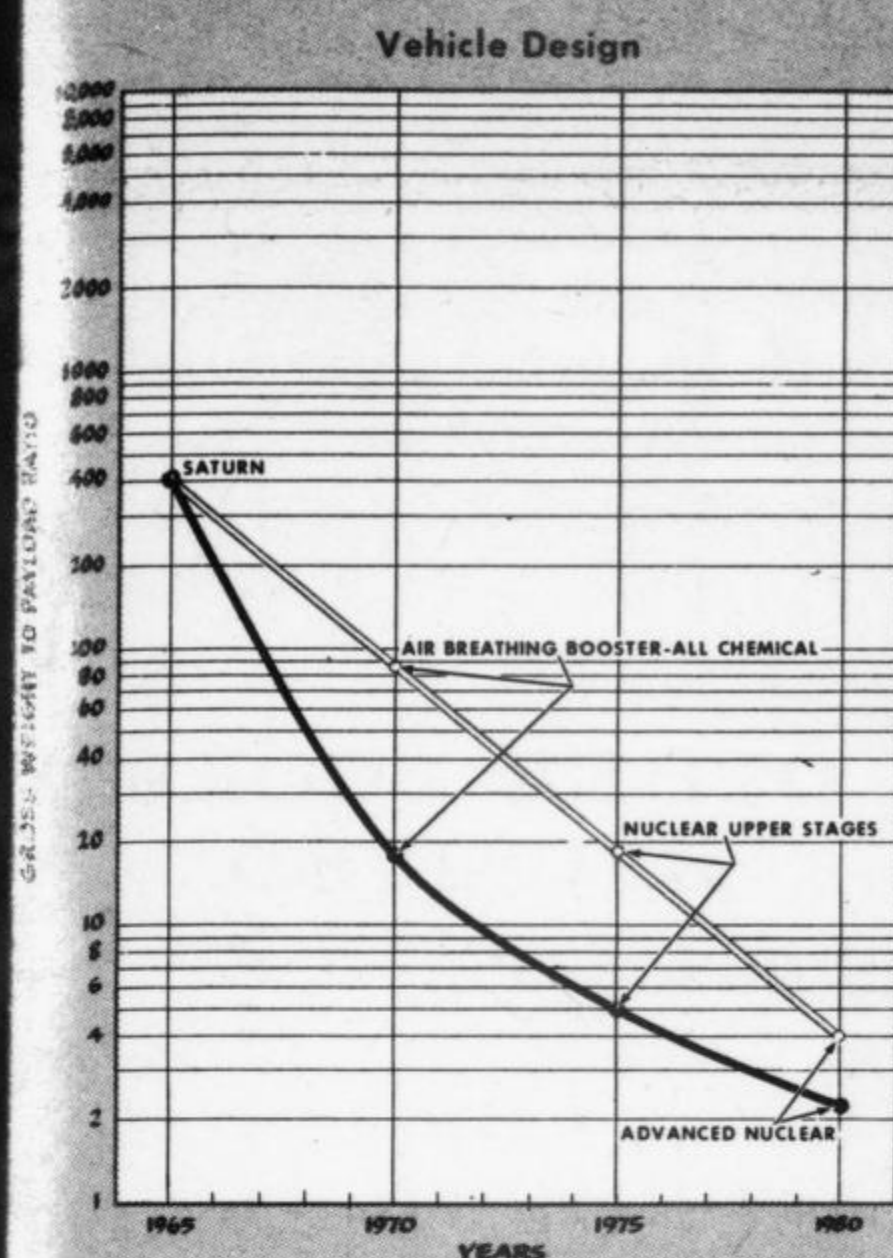
The steady outpouring of oxygen from that process assures the colony of a continuous supply of this vital gas. It is by such dovetailed techniques of applied science that the essentials of life can be manufactured on the moon. No breakthrough or basic research is needed, just workable hardware of a type which a dozen aerospace firms are working out now:

Moon Manor

What will be the actual form of the lunar colony's housing? Experts propose several types.

The most feasible seems to be to make a house simply by inflating a huge flexible dome. These domes would be made of plastics even tougher than mylar, the amazingly thin "balloon" skin of the Echo satellite. Such plastics are already being researched and would hold air even in the vacuum-like environment of the moon's surface. Within this anchored pseudo-blimp, the temperature can be regulated, via air-conditioning methods, against the extremes of lunar temperatures that range from about minus 250 degrees F. at night to plus 225 degrees by day.

However, two hazards still remain for inhabitants of such gas-bag housing. Both hazards are caused by lack of lunar air. The sun's unfiltered ultra-violet rays, not to mention the primary cosmic rays, would swiftly machine-gun all the colonists — unless present-day experiments with protective anti-radiation drugs, also needed in flights through the Van Allen belts, prove successful. Secondly, meteorites constantly bombard lunar landscapes. Only two good-sized meteors strike a square mile of the moon per day, but the innumerable tinier ones would swiftly puncture the plastic housing



until it became a leaky sieve.

One suggestion to ward off this ever-present danger comes from Dr. John S. Rinehart of the Colorado School of Mines, who proposes erecting a metallic "umbrella" over the plastic dome to absorb the impact of micrometeorites. Another such shield could be made from a rigidized outer plastic shell that would act as a "bumper", saving the inner plastic bag from penetration.

An alternative solution comes from Dandridge Cole, and is based on the puzzling fact that if the moon is a solid mass of rock and matter, its low density (half that of earth) doesn't fit the picture. One current theory among selenologists suggests that a labyrinth of caves exists for many miles down, making the moon a semi-porous sponge.

If so, any large-sized lunar cavern would be an ideal haven for a colony. With its entrance sealed and fitted with an air-lock, the interior could be filled with air without the extensive construction work required for a surface dwelling. The danger of radiation and meteors is neatly eliminated for colonists who live underground behind a rock shield. Light and power can be furnished by a thermionic nuclear unit which will undoubtedly be available by that time, using the new principle of super-heating ionized plasma around a reactor to release electricity.

The food for this cave colony would be grown and harvested by spacesuited farmers in moon hothouses situated outside the caves in lunar sunshine.

Will this kind of existence under maximum artificial conditions be too confining for humans, or lead to claustrophobia and other psychic ills?

On the contrary, avers Cole, this is a kind of life that many 20th-century people would hardly find alien. By choice, many city-dwellers today spend practically their

whole lives indoors, especially in certain huge buildings that hold not only offices but hotel rooms, barber shops, movie theatres, and facilities to meet all the needs of life without once stepping out of doors.

What is the difference, asks Cole, between *that* air-conditioned closed-cycle skyscraper "colony" and a similar cave colony on the moon? To forestall boredom, Cole includes recreation among the necessities of lunar life. In sports, the low lunar gravity will make for spectacular "olympics" where the athletes can high jump 18 or 20 feet and pole-vault up to 45 feet.*

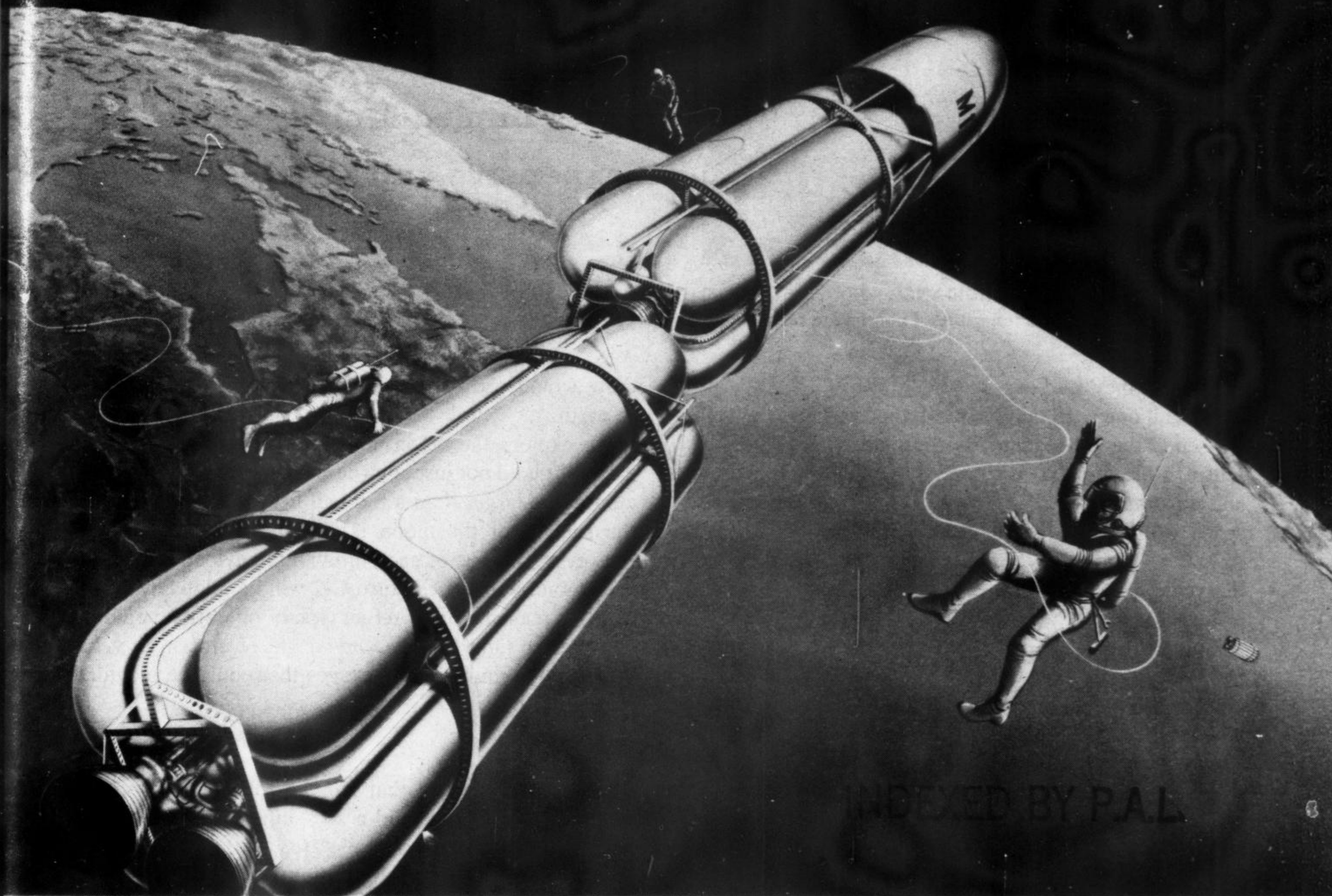
Besides these spectator sports, the colonists could do their own gymnastics and perform like strongmen, swinging dumbbells 6 times heavier than on earth. There is even a possibility that the lunarites may be able to fly with artificial wing-like devices by using pure muscular power. A man weighing 180 pounds on earth would only tip the scales at 30 lunar pounds, comparable to the weight of large flying birds on earth. With the cave's air to give aerodynamic support for synthetic wings, flying may be a lunar diversion envied by people on earth. Also, because of the light pull of gravity, physical labor on the moon would be ridiculously easy, almost eliminating fatigue.

Another bonus of lunar living, Cole reminds us, is that the "weather" up there would be ideal — no winds, rain, snow, floods, hail, lightning or storms can ever occur. And because the absence of a magnetic field around the moon precludes the existence of a pent-up molten metal core, there can be little if any geological upheaval — no moon-quakes, large-scale volcano eruptions, or ground faults that would menace surface ex-

(continued on page 50)

*Though the moon's gravity is 1/6th earth's, athletes could not leap 6 times higher since a jumper only raises his body's center of gravity, which is about 3 feet from the ground.

Space Refueling



REFUELING OPERATION. 2 boosters, 1 carrying auxiliary fuel supply, will be launched together and guided to meet in transit.

**In transit rendezvous will enable us to utilize
our existing hardware for extended space flight**

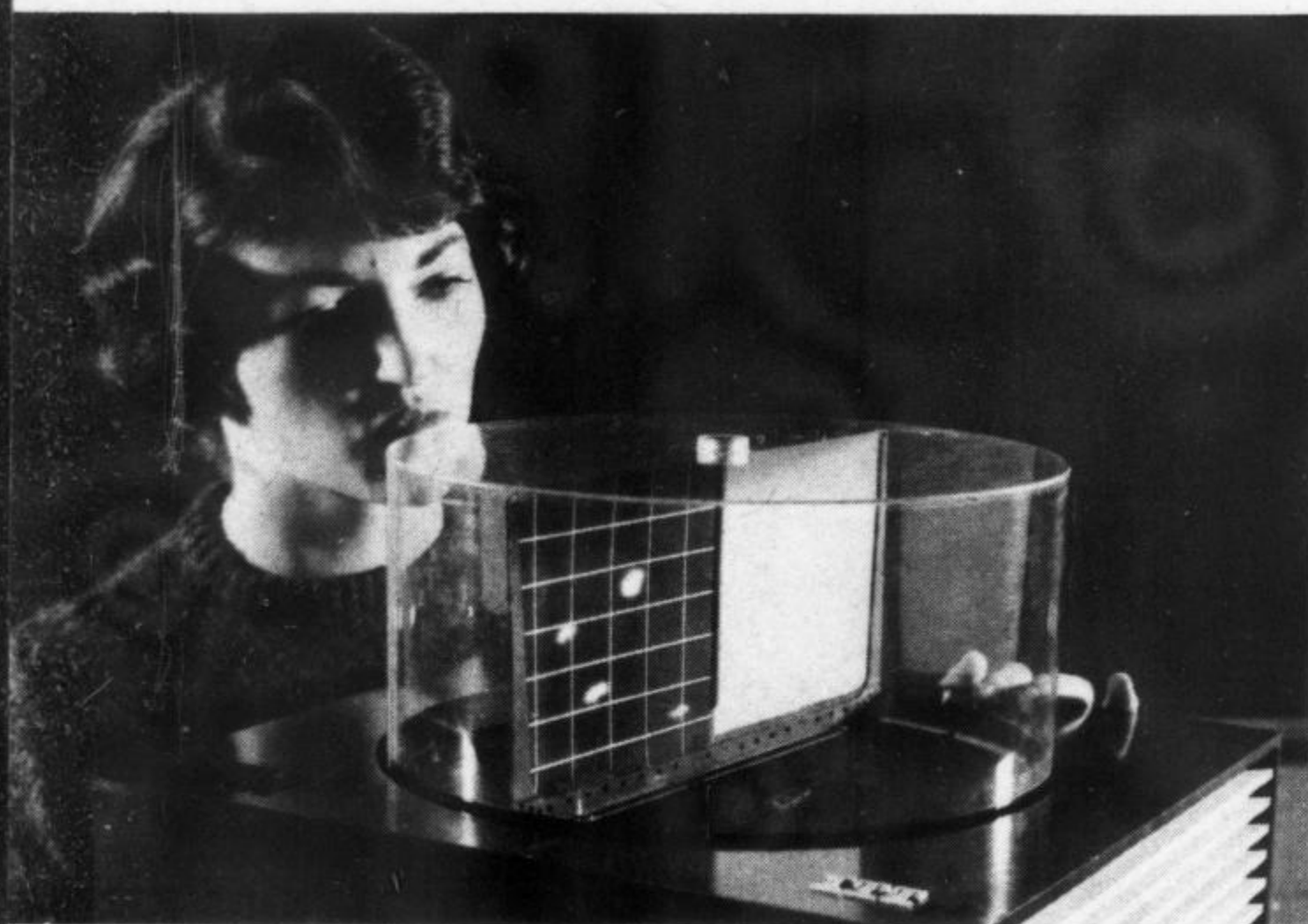
by CHARLES E. KAEMPEN

It's an historical fact that no exploration effort on earth has ever been considered complete until man himself visited the object of his interest. For this reason, our astronautic effort is pledged to continue the search for better ways by which man can explore his universe, not only by machine, but in person.

Space transport, like every transport operation, requires two things: a road and a vehicle. Usually, it is the road that determines the vehicle. This is because

the road, unlike the vehicle, has few engineering limits or complications. The vehicle, however, always depends upon such factors as propulsive thrust, number of stages, propellant efficiency, guidance and control, and structure design. Inevitably, every factor which contributes to vehicle improvement will reach a practical limit. We can see then that the road we select will ultimately determine future vehicle design, and the space projects centered around them. In astronautics we have a map of the roads into space. We refer to this map as "trajectory technology". Let's see now what these roads are

(continued on next page)



THREE-DIMENSIONAL GUIDANCE. 3-D control panel can be used to guide trajectory of boosters to rendezvous.

and where they lead us.

We call one road the Direct Method because the vehicle sends the payload to its destination, plus possible return, all by itself. It is simple. It is efficient. It is direct and uncomplicated. But if we use this road for manned space exploration it will prove to be very expensive. Actually, it isn't the road that is expensive. Rather, it's the vehicle we will need to travel this road that will be exorbitantly costly.

For example, if we used the Direct Method, we would need a five-stage booster 310 feet tall to hurl a landing crew to the moon, not to mention three return stages of a moon-booster, a crew cabin and a re-entry vehicle. This vehicle requires millions of pounds of propulsive thrust. It will take years to construct. It will take even longer before it is safe and reliable. Enormous vehicles such as this will also require expensive facilities on the ground.

Let's hope that when we pour money into space technology, we will pour it into research, not into concrete. Most of us realize that progress in space exploration, like progress in everything else, depends upon what we do with what we have. Let's look then at what we have.

What we have, or will have, is a vehicle now being built by the National Aeronautics and Space Administration: the Saturn C-2. So, if this is the vehicle, what is the road? Which road can this vehicle travel soonest? Safest? Most efficiently?

Obviously, since the Saturn is not large enough for lunar exploration by the Direct Method, we will need more than one of these vehicles to perform a manned round-trip lunar mission. One idea for using the Saturn C-2 is to launch, by the Direct Method, several individual payloads which would rendezvous on the surface of the moon. One of these payloads would contain the crew. The other payload units would be tankers, which the

Space refueling provides technique for space transport that is immediately feasible, inexpensive and reliable

crew would use to refuel their boosters for the return to earth.

To explore the moon in this way would require that each unit land not just anywhere on the moon, but within an area no larger than a football field. A rendezvous on the surface of the moon is, of course, quite feasible. However, the size of each individual payload landed on the moon by a single Saturn C-2 will be relatively small. For this reason a lunar refuel type of operation could be expected to limit the size and weight of a re-entry vehicle or other equipment packages that could be included on a lunar mission.

Anotner procedure that can be followed for an exploration effort is to land a self-sufficient expedition in a general area — not a specific area. If this procedure is used to conduct lunar exploration with the Saturn C-2 vehicle, it will be necessary to assemble the landing system in space before descending to the moon's surface.

One method to achieve this is to use a road we can call the Indirect Method. It involves refuel or assembly operations in a satellite orbit near earth. In one respect, this road is like a toll road. For we must pay an extra amount of velocity in order to enter and then leave the satellite orbit. As a result, this road can never be as efficient as the Direct Method.

This road is also more complex since the crew must perform a second launch operation before they can continue with their mission. This second launch operation will, therefore, require another in-orbit booster in addition to equipment which will land on the moon. It is important to recognize, however, that extensive trajectory studies have shown that such a rendezvous and assembly operation in space is definitely feasible.

Although it may not be ideal, this road could be followed by using the Saturn vehicle to perform in a manned
(continued on page 54)



SHUTTLE CRAFT. Artist's drawing, above, shows steps in orbital flight of manned shuttle craft that can be used to loft men and material to orbiting space station. Flight

path for this kind of operation will be calculated in the same way a space refueling trajectory is determined since the rendezvous technique in both cases will be identical.

SPACE VEHICLE NO. 1

THOR

SPACE WORKHORSE. With the recent launching of the Courier 1-B satellite, the Thor booster reached its 100th firing. As the first-stage rocket for the majority of the U.S. space projects, Thor has compiled an impressive record. In terms of usable payload weight, it has supplied the initial push for more than one-half of the payload pounds placed in orbit by the U.S. Although the first Thor ignominiously exploded on the pad on January 25, 1957, followed by three more discouraging aborts, it has, since the first successful launch on September 20, 1957, achieved an unsurpassed record of reliability with only 14 failures out of the 100 firings to date. The Thor-Delta configuration shown here has successfully launched both the Tiros II and the Project Echo communications satellite for NASA.

PAYLOAD

(NASA'S ECHO I)

Weight 240 lbs.
Diameter
(inflated sphere) 100 feet

THIRD STAGE

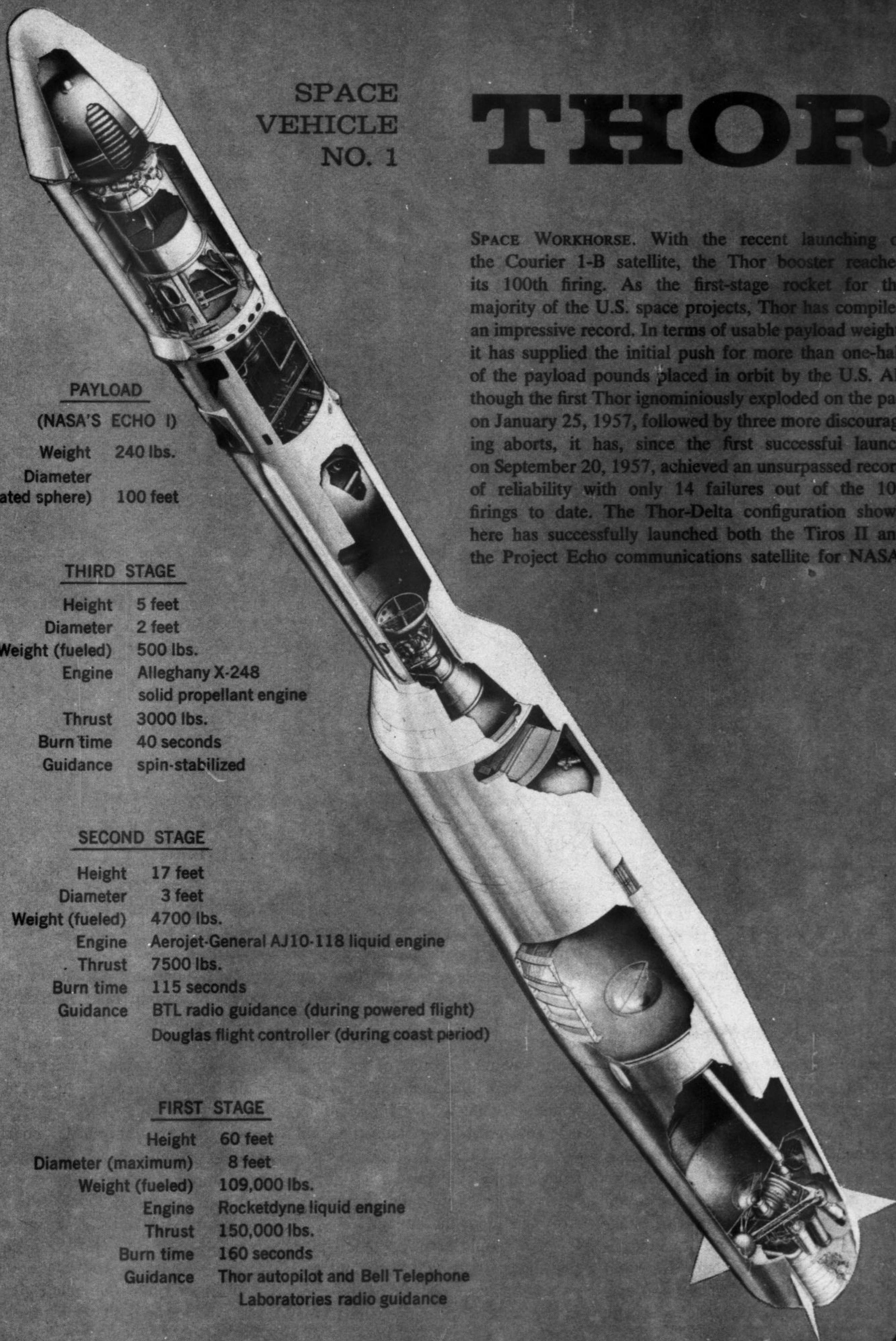
Height 5 feet
Diameter 2 feet
Weight (fueled) 500 lbs.
Engine Alleghany X-248
solid propellant engine
Thrust 3000 lbs.
Burn time 40 seconds
Guidance spin-stabilized

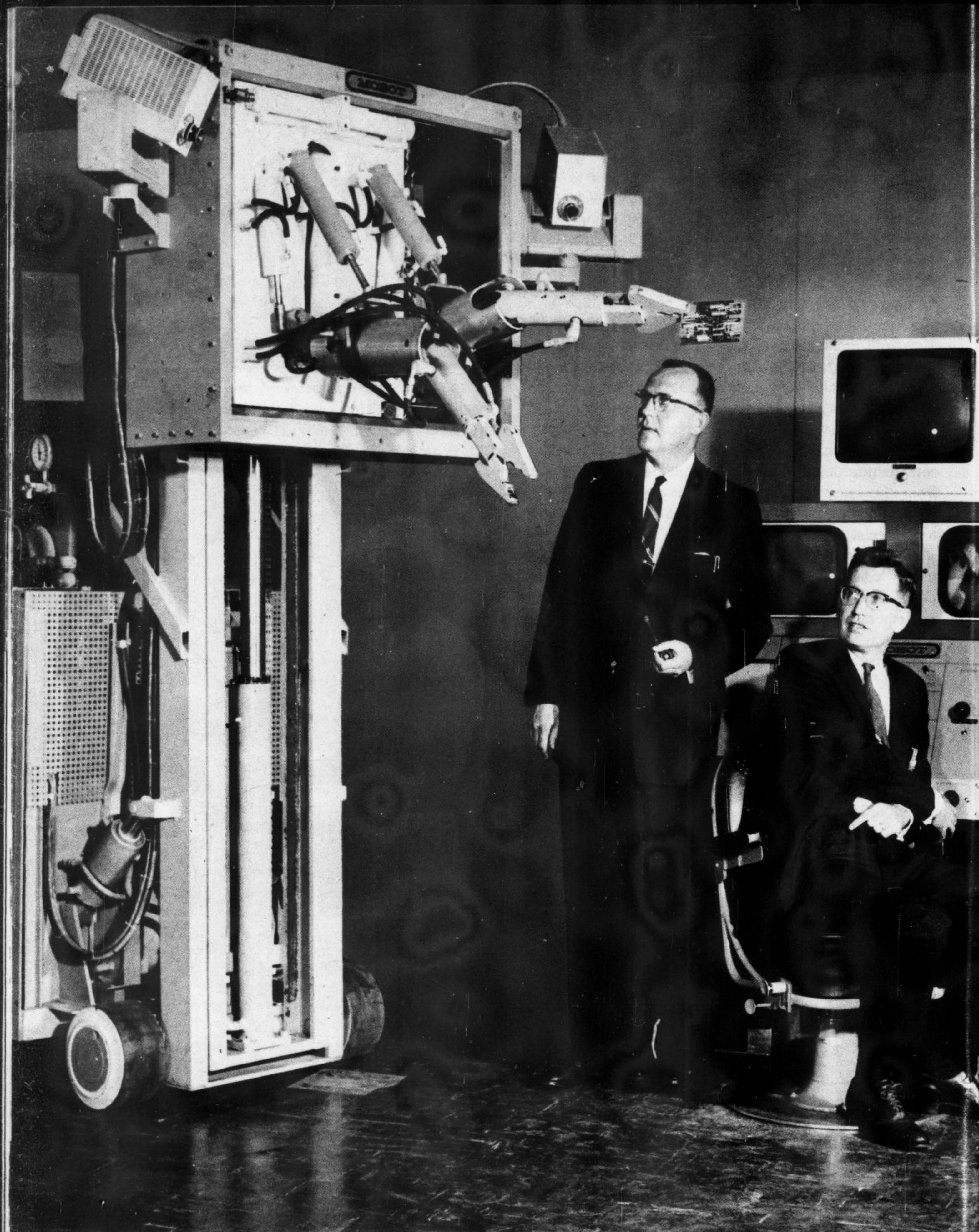
SECOND STAGE

Height 17 feet
Diameter 3 feet
Weight (fueled) 4700 lbs.
Engine Aerojet-General AJ10-118 liquid engine
Thrust 7500 lbs.
Burn time 115 seconds
Guidance BTL radio guidance (during powered flight)
Douglas flight controller (during coast period)

FIRST STAGE

Height 60 feet
Diameter (maximum) 8 feet
Weight (fueled) 109,000 lbs.
Engine Rocketdyne liquid engine
Thrust 150,000 lbs.
Burn time 160 seconds
Guidance Thor autopilot and Bell Telephone
Laboratories radio guidance





MOBOT FOR MAN. Operating in a radiation lab, this remote-controlled machine performs complex functions. Each arm can

lift 150 pounds and specially-designed hands can be used to assemble electronic parts, lift objects and move lab equipment.

MOBOTS

INDEXED BY P.A.L.

These servo-mechanisms can

be operated by remote control to explore and work
in environments that are dangerous or inaccessible

by JOHN W. CLARK

Our determination to explore space, the moon and later the planets, and to develop astronomical knowledge almost unimaginable today, is a challenge requiring the most creative applications of science. This article is concerned with remote handling techniques, which can be one of the important disciplines collectively making up "Space Technology".

Modern remote handling devices are being created by a combination of electronic control engineering (as developed for guided missiles and radar), human engineering (as developed for aircraft cockpit design) and remote control systems (as employed in the nuclear industry).

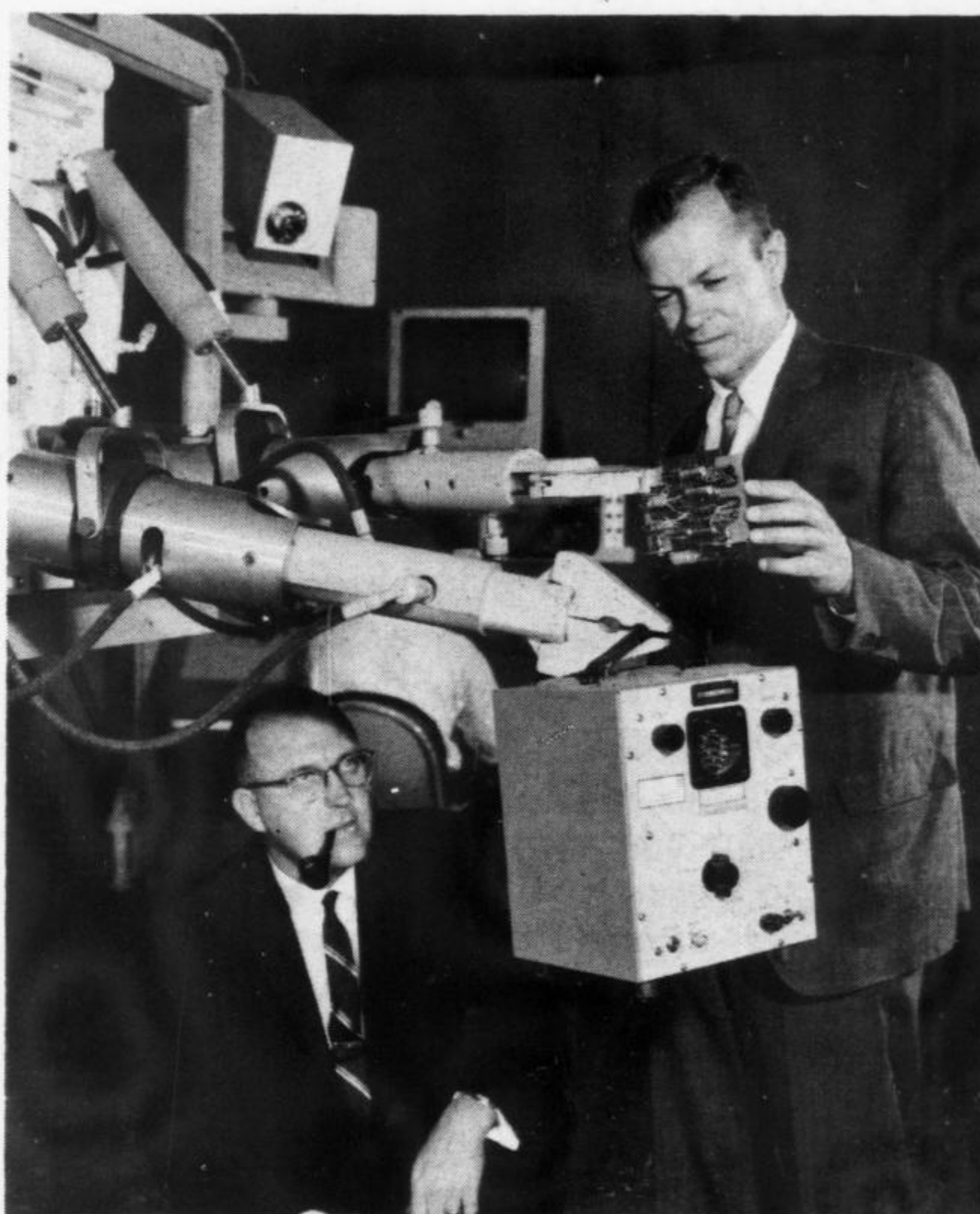
Slavo-machines and servo-systems can now be built which enable a man to work by proxy in a hazardous area he cannot enter personally. This would obviously include space. The new field of remote handling processes is sufficiently unfamiliar to justify a few basic definitions before exploring its applications to space programs.

The Fundamental Problem

Consider, as a simple example, the task of removing a spark plug from a modern automobile engine. Visualize that the entire automobile is contained within a hazardous area which cannot be entered by personnel. Say, for instance, that the car is right next to an unshielded atomic reactor. Ignoring the unrealistic situation, how would you get that spark plug out?

In the past, problems of this type were attacked by the use of long tongs or forceps. Some of these devices have become extremely complex and employ hydraulic or electromechanical actuators to supplement the physical strength of the human operator. All such devices may be considered extensions of the man's arms. The man himself is positioned just outside the hazardous area, protected by a suitable barrier or shield.

But let us assume that the separation between the hazardous area and the safe area is so great that tong-like tools cannot be used. We then squarely face the problem of operating in an inaccessible area. This is sometimes solved by providing the operator with pro-



MARK I. First model, now used in nuclear installation, is inspected by R. Henderson, left, and Dr. A. Puckett, developer.

TECTIVE clothing suitable for defying the environment. Deep-sea diving suits, for instance, serve this purpose in the underwater environment. Movable personnel shields may be used in nuclear environments. And, of course, the space suit is logical for the space environment.

In all such cases, however, we have not actually solved the basic problem. We have, on the contrary, merely reversed the procedure so that the safe area is now contained *within* the hazardous area. But the operator is still separated from his work and must use long tongs in most cases rather than his own hands for manipulation.

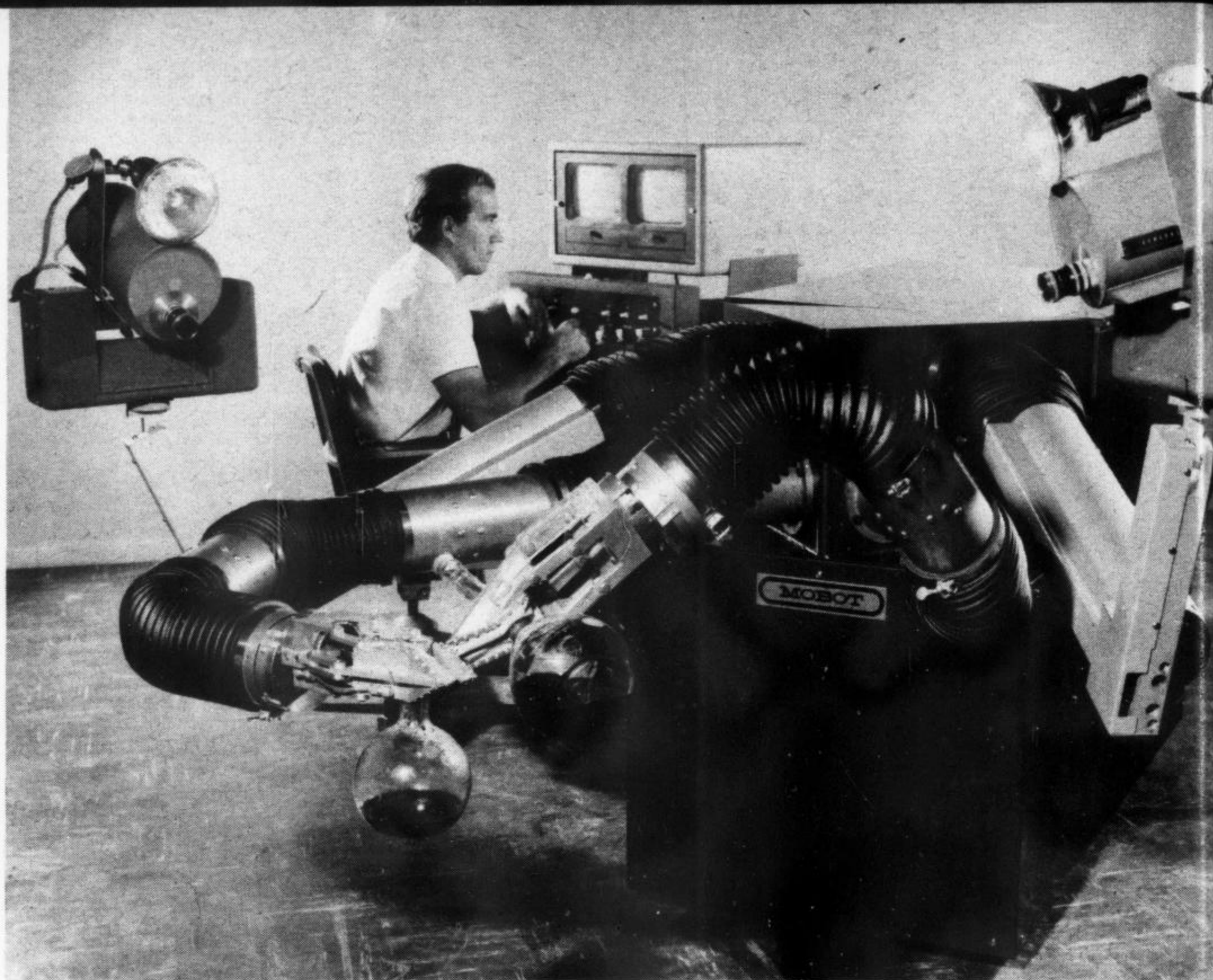
To solve the fundamental problem in all cases, let us analyze a man in terms of a machine-like handling system. Note that just four interrelated physiological

(continued on next page)

MOBOTS

continued

**Man's ability to
do useful work
can be extended
into almost any
environment**



systems are involved: his brain, his eyes, his hands, and his feet. The eyes, through their sensory nervous system, provide information concerning his surroundings. The hands, as controlled by the motor nervous system, can move objects as desired. The feet and legs, controlled by their separate locomotor system, enable the entire organism to move about. Finally, the brain assembles and organizes data and directs the combined systems. In this context, the man/mechanism is comparable to a true machine.

The three mechanical functions symbolized by eyes, hands and feet may readily be supplemented by modern electronic means. In this way, a man's senses and his ability to accomplish useful work may be extended to any distance, while his body and brain remain in safety and comfort at any chosen location.

This simple concept is the basis of our new remote handling systems, involving mechanisms we call Mobots. These are under human control as distinguished from the traditional robot that is presumably under its own control. Mobots are not to be competitive with Man-in-Space. Rather, the effective utilization of Mobot systems will increase and supplement man's ability to accomplish functions in space. The concept of remote handling systems can be applied to several realistic astronautics endeavors by designing specific astro-Mobots.

The General Mobot

As noted above, remote handling systems are artificial extensions of man's senses and muscles over considerable distances. In order to accomplish this, a link must be provided that bridges the physical gap between man

and Mobot. Also a command-data control console is needed with which the man communicates with the remote machine.

The term "Mobot" was coined to refer specifically to the *mobile* remote portion of this servo-mechanism system. Mobots, then, are the mechanical units and are the most conspicuous part of remote controlled systems. One basic psychological advantage is the ease with which a Mobot's human operator learns to identify himself with the mechanical slave to the point of forgetting there are interconnecting systems. This man-machine identification appears to be a basic necessity for successful operation of very distant Mobots as in space operations. The man, in a sense, becomes the Mobot.

The separate Mobot functions take different handling skills:

Hands and Arms. It seems impossible to avoid these anthropomorphic terms — hands and arms — when referring to the manipulating devices. However, these do not much resemble human hands or arms, but are designed specifically to perform their various tasks. Though it is difficult to rival the versatility of the human hand, special-purpose Mobot appendages can usually outperform the human hand in any single category, such as dexterity or strength or small size, or some other special attribute. More-than-human strength is almost always included, but beyond that, Mobot manipulating systems must be able to work around obstacles and to perform intricate motions. Even the removal of an automobile spark plug, as in the example previously cited, becomes surprisingly difficult to accomplish from a distance via servo-mechanical means.

The Senses. While all human senses can readily be

REMOTE HANDLING SYSTEMS IN SPACE

Region	Application	Operator Location	Communication Link	Mobot Weight	Approximate Date
Cis-Lunar	Small Satellite Maintenance	Space Ferry	Cable	100 to 500 lbs.	1965
	Large Satellite Assembly In Orbit	Surface	Communication Satellite	300 to 1000 lbs.	1970
		Space Ferry	Cable		
	Large Satellite Maintenance	Satellite	Cable	100 to 500 lbs.	1973
Lunar	Scientific Data From "Soft" Lunar Landing	Earth	Microwave	30 to 100 lbs.	1963
	Construction Of Unmanned Lunar Base	Earth	Microwave	500 to 5000 lbs.	1968
	Manned Lunar Exploration	Lunar Base	Microwave UHF and	500 to 5000 lbs.	1973
Trans-Lunar	Explore Planetary Surface	Space Ship	Radio	?	1990

transmitted via electronic means, vision is the most important by far. The closed-circuit television system that must be used requires spatial orientation which is accomplished by a variety of methods. Parallax scale (degree of side motion), relative motion, and the like, are the most important in astro-projects. Binocular vision is surprisingly unimportant, as demonstrated by the fact that one-eyed men are little handicapped in perceiving geometric orientations in their vicinity. In our Mobot development, excellent success has been obtained with a simple vision system utilizing two TV cameras which show the operator two mutually perpendicular projections of the area viewed. From this he can learn to deduce the orientation and relative positions of all objects within his visual field. Learning time of a few hours has proven quite adequate to become a good Mobot manipulator.

Locomotion. In order for the Mobot to move freely in airless space, locomotion is provided by auxiliary jets, located to provide proper changes of attitude, up/down movement, and rotation. That is, it allows the Mobot unrestricted movement in the three dimensions of space, much like the jet-guide system of the X-15. On lunar or planetary surfaces locomotion may be provided by conventional wheels or by quite unconventional walking devices that become practical with the use of Mobot control circuitry. For operations inside large orbiting satellites or around their outside hulls, locomotion is readily obtained by grasping hand-holds or other protuberances with the same arms the Mobot uses for handling objects and tools.

Command Data Link. This communication link between human operator and Mobot must obviously pro-

vide command information at a rapid rate to control the servo-mechanism. It must also transmit sensory data from Mobot back to operator. For short distances a cable may be used, which can also transmit power to the Mobot. For longer distances, conventional telemetric links are feasible, based on command-radio techniques already used to stop and start satellite instrumentation up in orbit.

Power Requirements. Prime power to run the Mobot that is under remote radio command may be furnished by any of the familiar satellite power sources, such as battery current plus solar-cell recharging. Radioactive power typified by the SNAP series (in which a nuclear isotope generates electricity by the thermocouple principle) is particularly appropriate for small Mobot space systems. Larger astro-Mobots would require the higher wattage furnished by thermionic generators (in which a nuclear reactor acts on high-temperature plasmas).

Control Console. This is the man-machine manipulating link. Principal design requirements are operator comfort and convenience. After a considerable learning period, an experienced operator becomes completely unaware of the console and subjectively identifies himself with the Mobot, as mentioned before. The console must be designed to promote this "togetherness" to where the operator unconsciously controls the Mobot's hands or legs as if they are his own.

Mobot Experience. The concept of a fully-remote mobile handling system has already been proved practical in the Mobot Mark I, which was used in a nuclear radiation laboratory in many months of successful operation. Such operations as pouring liquids, opening and closing doors, operating power tools and the like, were

(continued on page 44)

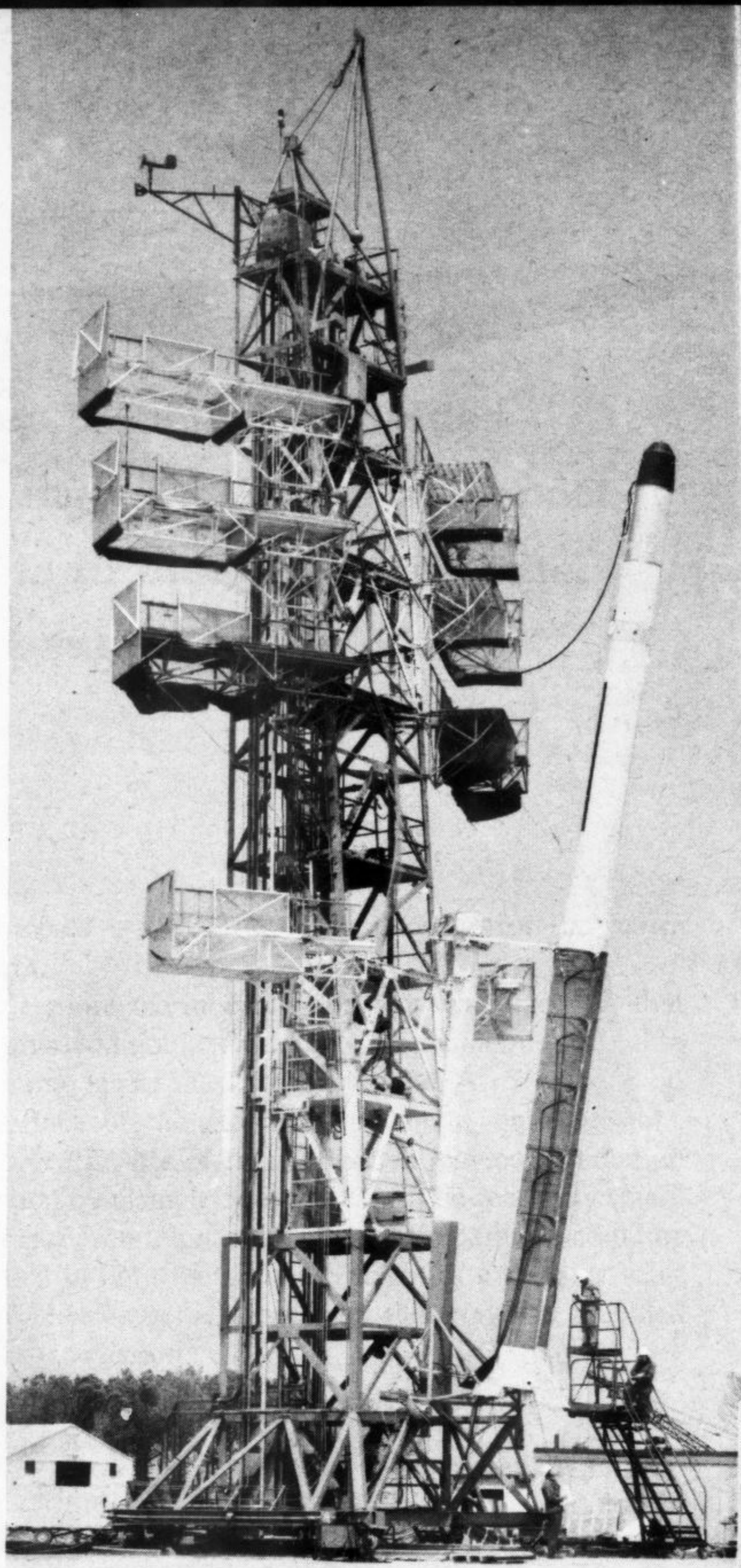
1-USSR

2-USA

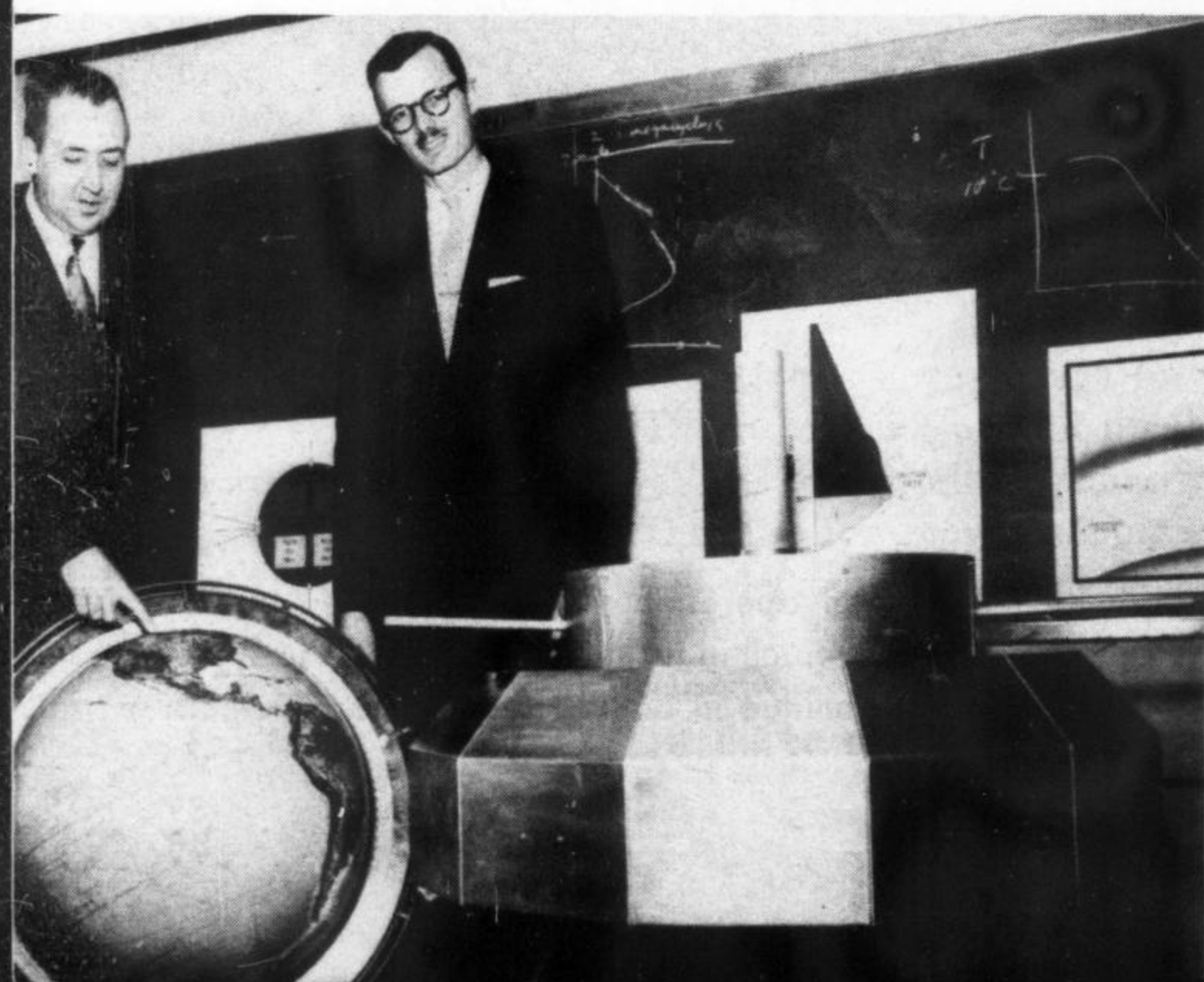
3-????

**Here are the leading candidates
for third-place honors in space**

by ROBERT GRANVILLE



AMERICAN BOOSTER. NASA has offered this Scout booster to COSPAR members for use as satellite-launching vehicle.

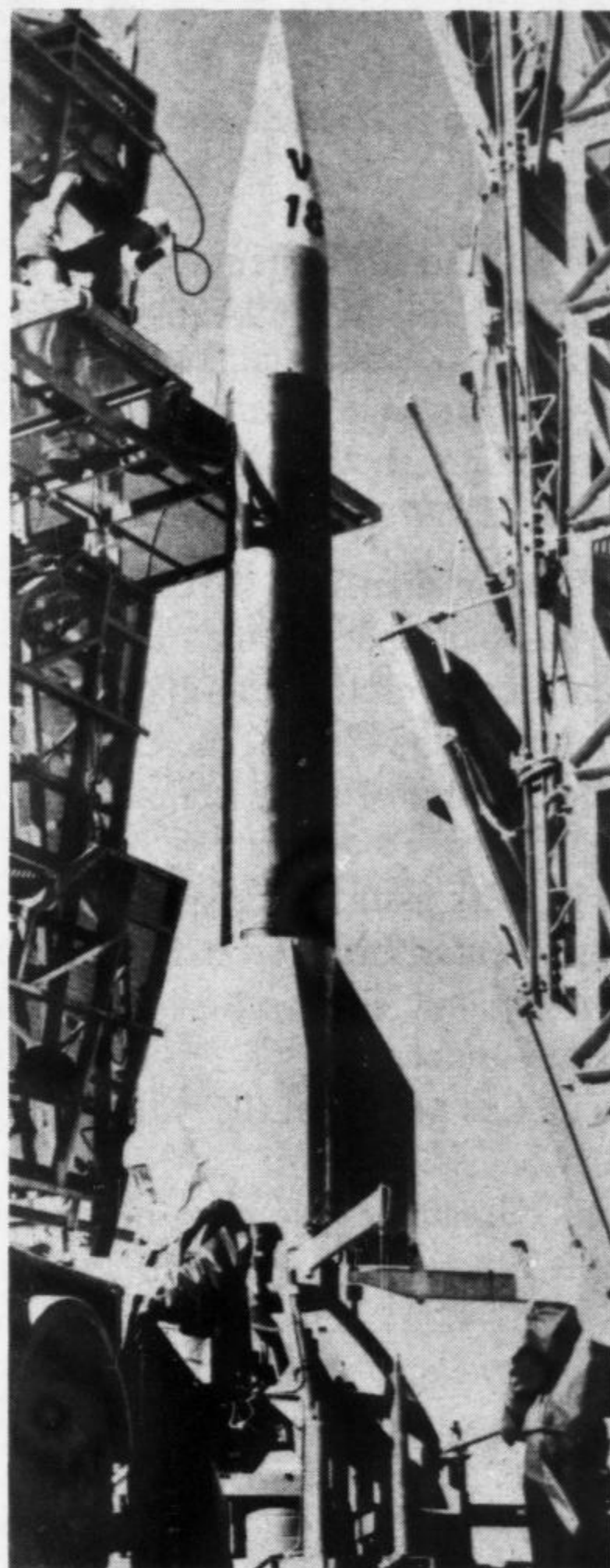
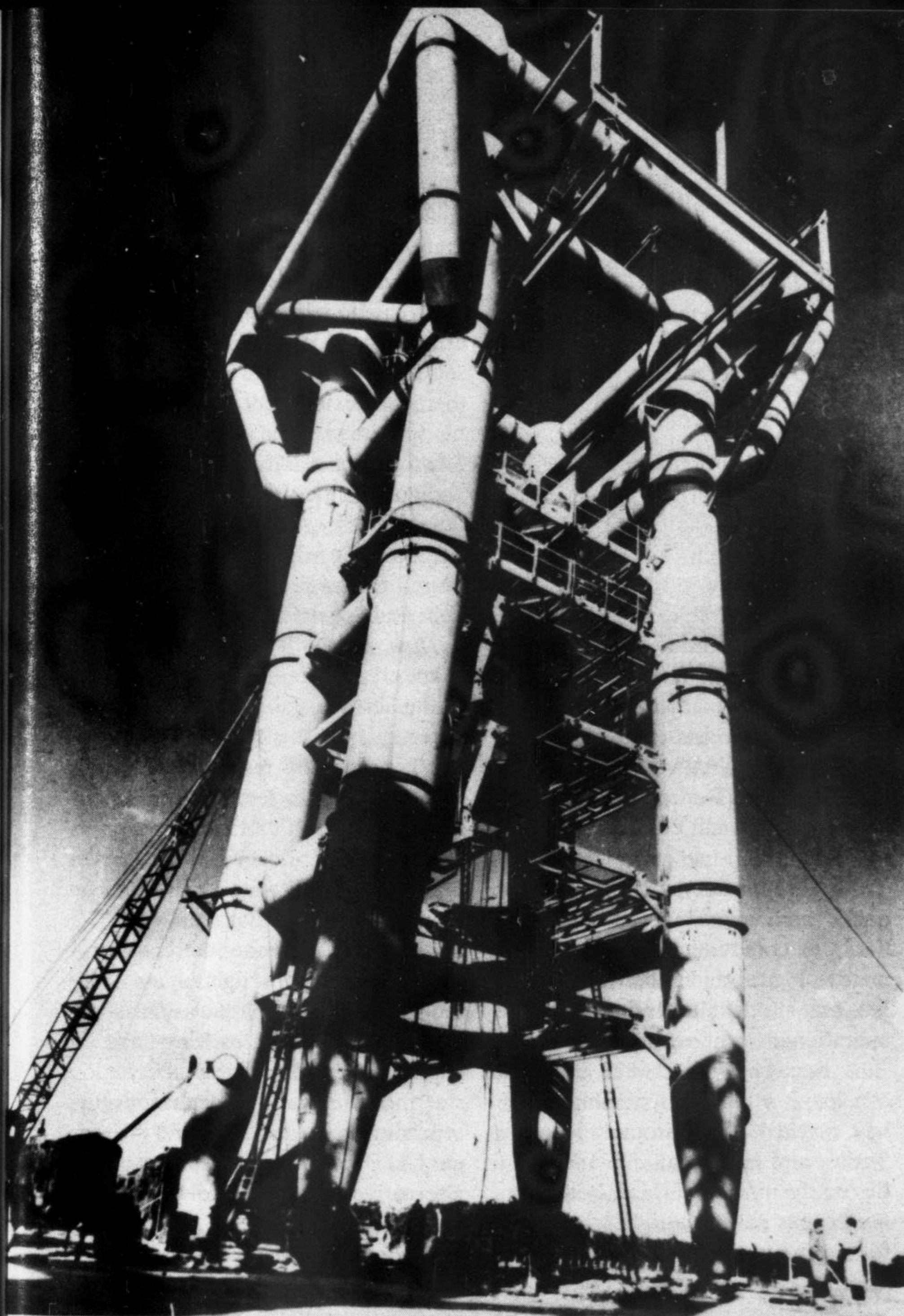


Today, only a handful of nations have anywhere near the sophisticated technology, scientific spread and sheer economic muscle to follow the USSR and USA into space. These are England, Canada, France, Italy and — surprisingly — Red China.

It is from among those five nations that the next member of the space elite will come. All of them have announced plans for eventual satellite launchings, though none has set a firm date. But 1961 is likely to see the debut of another country in space.

Britain was the third nation to contrive its own atomic bombs. It also hopes to be third in joining the

CANADA. Scientists examine mockup of Canadian satellite. Due to go into orbit in '61, will be powered by American Thor-Delta.



FRANCE. Technicians prepare the Veronique rocket for a test launching in Sahara desert. French scientists are still being hampered by lack of funds.

ENGLAND. Launching gantry near Hatfield is ready for Britain's coming satellite. English will use Scout booster to orbit their first space vehicle.

exclusive Space Club.

As long ago as September 7, 1958, the English test-fired the Black Knight, the first British missile with space possibilities. This single-stage liquid-propelled vehicle, 35 feet long, achieved an altitude of between 300 and 400 miles. However, its speed of 8,000 mph was less than half of that needed for orbital velocity. It would make an ideal second stage — if only it had a booster.

To develop a more powerful basic vehicle, the influential British Interplanetary Society urged Her Majesty's government to form the British Commonwealth Space Exploration Program. After authorization, the program got under way early in 1959 when research and devel-

opment work was begun on the Blue Streak, a huge missile which English scientists hoped would double as both IRBM and space booster. Australia's Woomera Rocket Range was available for test flights of several thousand miles into the Indian Ocean.

Blue Streak specifications show it to be somewhere between an IRBM and ICBM in size, power and performance. Seventy feet long, with twin motors developing 135,000 pounds of thrust each, its range is at least 2,500 miles. Its burnout velocity at 500 miles altitude is 18,000 feet per second (12,000 mph).

With a second-stage Black Knight added to the Blue Streak, the two-stage vehicle would be able to achieve an orbital speed of over 17,500 mph for a healthy pay-

(continued on page 46)

DECEMBER 50¢

SPACE WORLD

The Magazine of Space News

A SPECIAL ISSUE

**PREPARED IN COOPERATION
WITH THE UNITED STATES AIR FORCE**

MEN IN SPACE



Alan Shepard



Virgil Grissom



Yuri Gagarin



Gherman Titov

- Are the Russians really ahead?
- Training the Dyna-Soar pilots
- The Danger Zone in outer space
- What's next in Space Travel

SPACE WORLD

The monthly magazine of space news • DECEMBER 1961

CONTENTS

- 13 WHAT'S AHEAD IN SPACE TRAVEL,**
by George P. Sutton
General Electric scientist tells about systems for manned flight.
- 16 SPACEMAN'S ENEMY — THE SUN,**
by Walter Orr Roberts
Solar radiations create a serious hazard to manned space flight.
- 18 SCOUT LAUNCH**
Picture report on satellite launching with a solid-fuel booster.
- 20 SEEING AND HEARING IN SPACE,**
by Hubertus Strughold
An authority examines some effects space has on the human senses.
- 22 THE DANGER ZONE,** by James A. Van Allen
Magnetically trapped radiation belts influence space flight.
- 25 NOW IN TRAINING — DYNA-SOAR PILOTS,**
by Col. Burt Rowen
A detailed report on training programs for our first space pilots.
- 28 THE PROBLEM OF STERILIZATION,**
by E. Staten Wynne
Steps to prevent the contamination of space with earthly bacteria.
- 32 TO THE BREAKING POINT,**
by Bryce O. Hartman
Determining the limits of human endurance and capacity in space.
- 37 PREPARING MAN FOR SPACE,**
by A. Blagonravov
A Russian scientist reports on the Soviet 'Man-In-Space' program.
- 40 PICTURE NEWS**
A photographic report on this month's new developments in space.

DEPARTMENTS

Letters	4	36	Names in the News
What's New	10	43	Space Quiz
Orbiting Around	6	44	News You Can Use
Question Box	8	46	The Scientific Amateur
Jets and Rockets	24	50	Book Reviews
	63		Spaceword Puzzle

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EAST COAST ADVERTISING: Space World, Suite 315,
250 West 57th Street, New York 19, N.Y.

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ON THE COVER: This issue features Alan Shepard, Virgil Grissom, Yuri Gagarin, and Gherman Titov, the first four men who have left the earth's atmosphere. Their experiences have provided invaluable data for the next steps in manned flight systems.

MEN IN SPACE

For the first time in history man has ventured beyond the protecting mantle of earth's atmosphere. He has taken his first tentative steps into space—into a completely alien environment. What are the dangers our astronauts face? Will man be able to survive a trip through the deadly radiation belts that girdle the earth? How will our engineers tackle the immense problems of creating a habitable micro-environment for our spacemen? What are the limits of human endurance when confronted with the awesome challenge of space?

To answer these questions SPACE WORLD has prepared this special issue with the cooperation of the United States Air Force School of Aerospace Medicine. On the following pages, some of our leading authorities report on these problems. They describe the latest experiments in testing and evaluating the human organism when subjected to the rigors of the space environment. They report on the latest findings on celestial and solar physics, and peer into the future with sophisticated predictions of things to come.

Here, then, in this special issue, SPACE WORLD brings you the first, comprehensive report on "Men In Space." Thanks are due to the USAF School of Aerospace Medicine and to Major Robert McDougall, without whose help and cooperation this special issue could not have been compiled for you.



What's ahead in SPACE TRAVEL



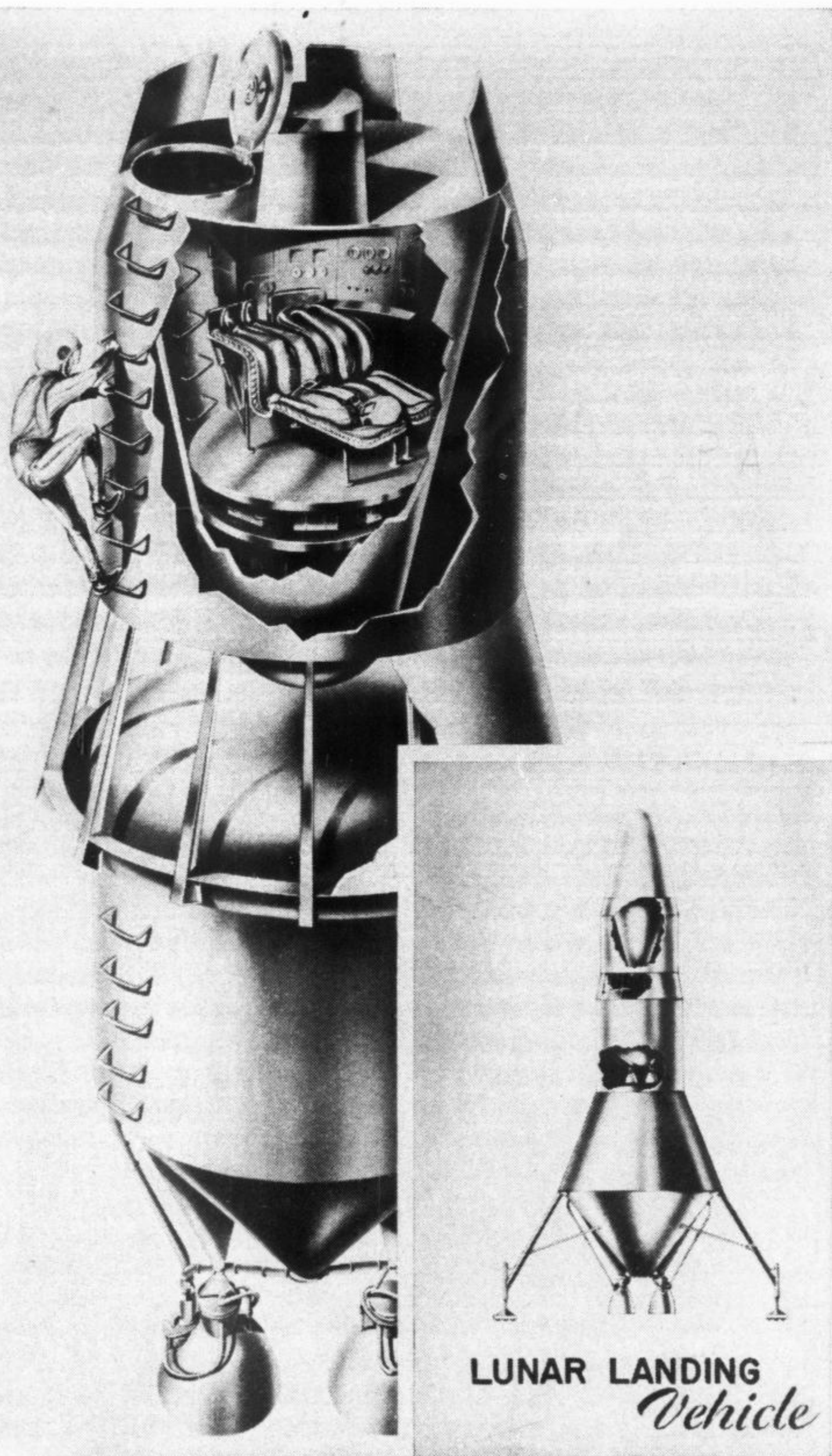
by GEORGE P. SUTTON

*In the next few years
daring men will take the
long, hazardous pathway
to the stars*

turn page →

INDEXED BY P.A.L.

Interplanetary exploration is our ultimate goal



Apollo Lunar-Landing Vehicle. Schematic drawing above shows NASA's proposed three-man lunar vehicle now under development. The space ship is designed to be boosted by giant Saturn C-3. Concept is by the GE Corp.

We are at the threshold of man's great adventure beyond the atmosphere and his exploration of the thin, vacuous environment of space. We are all thinking and planning for the more complicated and demanding manned space missions which will undoubtedly follow the early experiments. Our immediate problem is to determine that man can survive in space. In the first flights he will serve only as a test specimen. Thereafter we will see if he can function effectively as an observer and ultimately as an operator.

We must first make a distinction between exploratory (research) flights and those used in space *operations*, the latter meaning a system that is developed and used in a relatively routine fashion.

The future progression of extended space operations will proceed along related lines that include four different classes of manned space vehicles: (1) single-man experimental vehicles, (2) multiman vehicles, (3) space stations, and (4) vehicles for multiship expeditions.

In 1962 we intend to orbit a man in a simple non-maneuverable Mercury capsule. It has a simple re-entry capability with no mechanism to alter its course, only change its attitude. The Dyna-Soar type vehicle, the next major single-man test vehicle, will be capable of some orbit maneuvers at low altitude. This comprises the first class of manned vehicles, those primarily exploratory in nature.

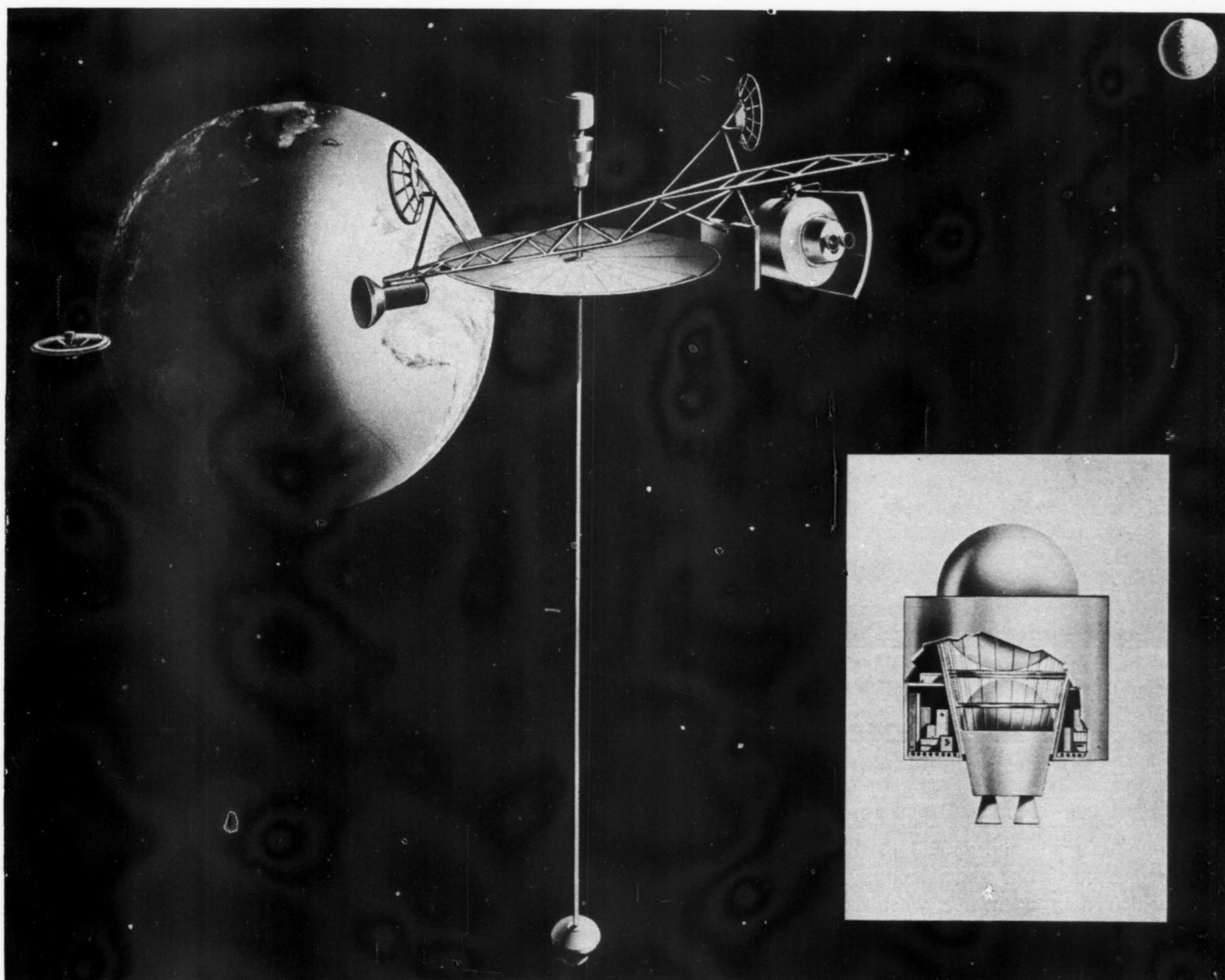
The next major class will be larger in size, with a crew of two men or more, and staying up for longer durations in higher orbits. The Apollo-A vehicle is representative of this class.

The third class of structures is first temporary, then semi-permanent, and eventually permanent space stations. They will start with operations in near earth orbits. Later versions will go in higher orbits and perhaps serve eventually as space stations for lunar flight.

The final class of vehicles are those for interplanetary exploration and operation. Rather than a single vehicle, a squadron of several vessels will probably go together to explore distant parts of our universe.

The flight duration will increase with each class of vehicles. The *takeoff weight* and the *final payload* will both become increasingly larger with mission difficulty. For example, guidance requirements will become more complex; re-entry accuracy and heating problems will become more serious; and requirements for maneuvering and attitude will become more stringent.

The concept of *modular design*—meaning the use of compatible structural parts that can be added to assemble varied types of vehicles—will be used. For example, in the Apollo design, it is possible to have a final-stage “building block” vehicle which contains all the essentials for human survival, re-entry, and flight control.



Ion-Propelled Space Ferry. This advanced vehicle will transfer men and materials from an orbiting space station to the moon

Attached thereto are separate modules for propulsion during orbital maneuvers and for life support equipment in extended orbiting trips. During re-entry, all redundant modules are dropped off in orbit and only the final-stage vehicle returns to earth.

More complexity will also apply to *crew engineering* and life support systems. For example, artificial gravity for the crew is a nice thing to have but in the minds of some experts it is not essential for a few weeks in the early manned satellites. The luxury of induced weight will come later in long flights.

Systems for cabin environment control must be provided under all circumstances. Backup systems of advanced climate control are again essential only for the longer duration missions where escape or return to the earth is not readily possible.

In the early manned space activities, the *supply of*

food will be stored in containers. Regenerating the food supply through a closed ecological system will be required in longer interplanetary missions. Disposal of carbon dioxide and waste liquid products becomes increasingly complicated with longer flight durations.

For short-duration missions, chemical sources of power seem to be adequate. But in long journeys with need for the higher power associated with larger payloads, the *nuclear reactor* generator may be a necessity.

All manned space systems call for an attitude control system for orientation toward the earth or the sun, for proper communication antennae angles, for adequate solar energy capture, or for effective manned observations. In addition, advanced manned satellites must have an onboard system for controlling orbital heights, speed, plane of path and period of revolution.

(continued on page 42)

SPACE WORLD

NOVEMBER 50c

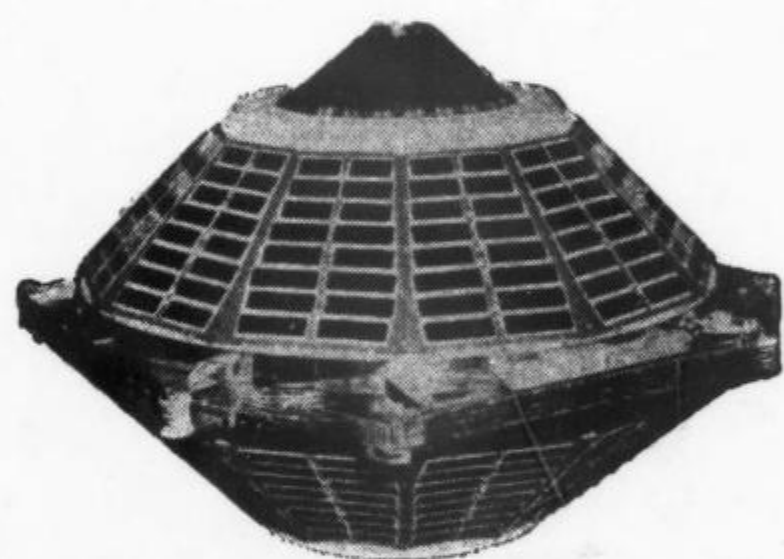
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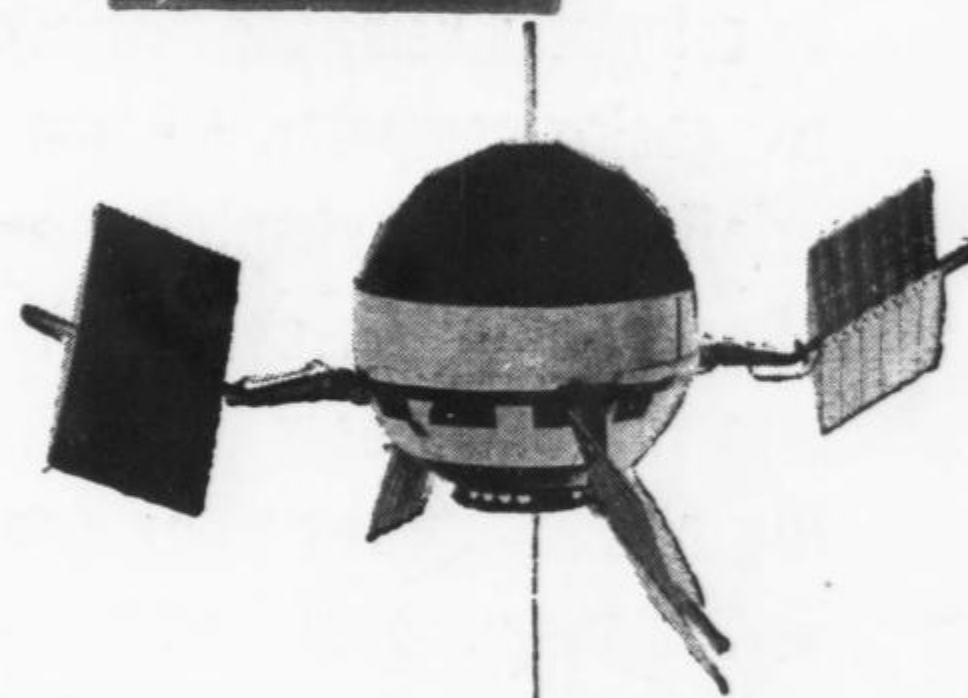
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LIFE ON THE MOON? • ROCKET MAIL • REPORT FROM RUSSIA

SPACE WORLD

The magazine of space news • NOVEMBER 1961

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LIFE ON THE MOON? • ROCKET MAIL • REPORT FROM RUSSIA

ON THE COVER: This issue features two of the many satellites that have been launched by the United States in our space program. Pioneer V, left, and Explorer VII, right, have played important roles in instrumented exploration of the space environment.

CONTENTS

- 12 IS THERE LIFE ON THE MOON?**
by John Rublowsky
New data suggests that the moon may not be a sterile satellite.
- 16 WHAT'S IN SPACE FOR YOU?**
A review of NASA's space program and how it will benefit you.
- 18 BATTLE OF THE BOOSTERS,** by Otto O. Binder
New solid-fuel boosters offer some unique advantages over liquid.
- 20 U.S. SPACE VEHICLE GUIDE**
Complete picture list of all our space vehicles launched to date.
- 40 PACIFIC MISSILE RANGE,**
by Rear Adm. Jack P. Monroe, USN
A new missile testing range is now being completed in California.
- 42 ROCKET MAIL,** by Willy Ley
High speed mail service between any two points is now possible.
- 44 SAFE ROUTES FOR MANNED SPACE FLIGHT,**
by Georgy Pokrovsky
A Russian scientists maps the routes for interplanetary flight.

DEPARTMENTS

Letters	4	52	The Amateur Scientist
Orbiting Around	6	55	Book Reviews
Question Box	8	58	Jets And Rockets
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What's New	47	63	Spaceword Puzzle

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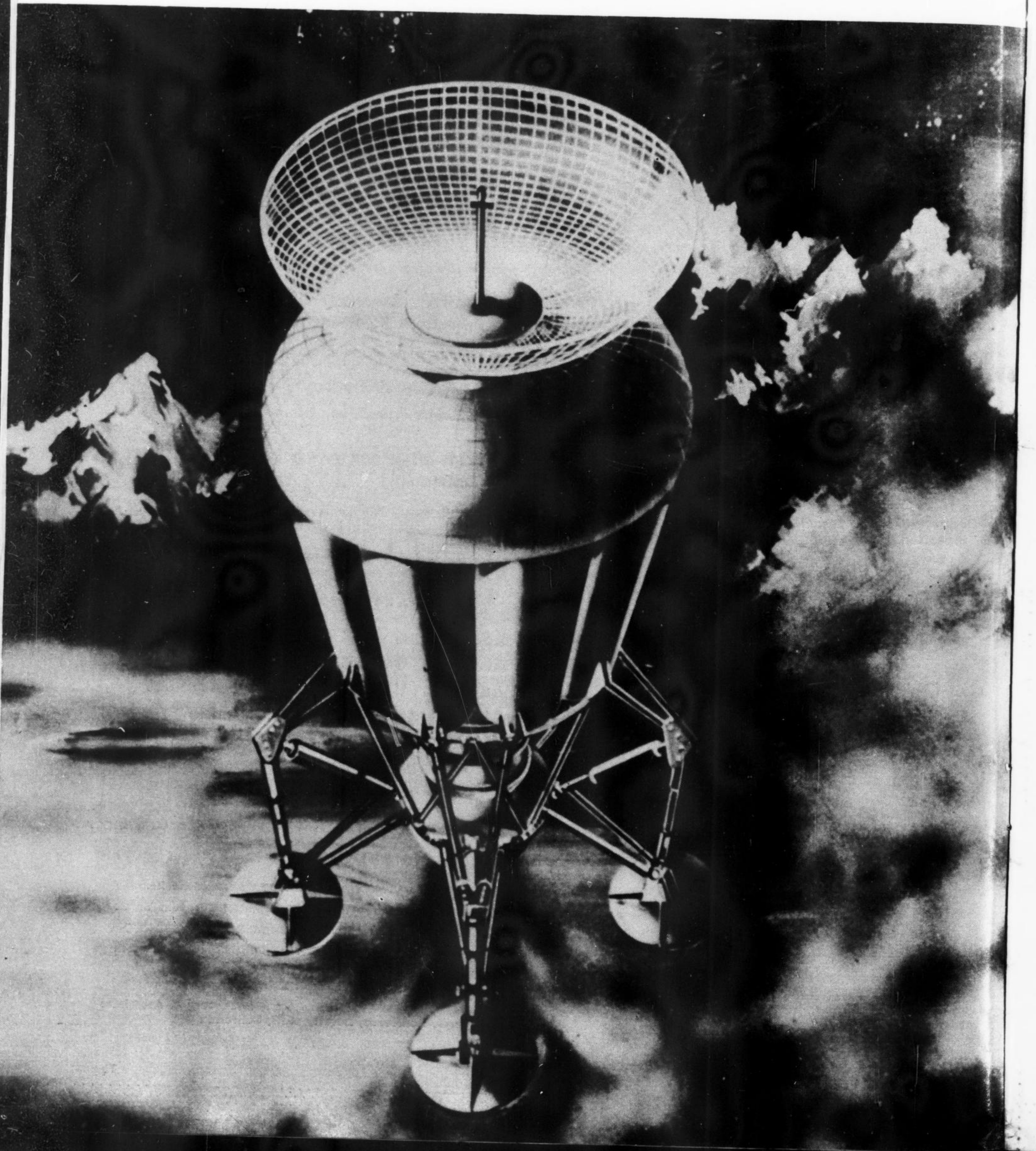
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IS THERE LIFE ON



INDEXED BY P.A.L.

THE MOON?

by JOHN RUBLOWSKY

For many years the moon has been held up as a perfect example of a lifeless satellite. Astronomers point to the temperatures that range from a blistering 214 degrees Fahrenheit in the sun side, to the frigid minus 243 degrees on the dark side of the moon. They cite the almost complete lack of atmosphere as proof that life could not exist on so hostile a world.

The moon has been described as a place of complete desolation where nothing ever happens. Where there is no air there can be no clouds, no rain, no sound. Within a dark lunar cave there would be eternal silence and inaction. A spider web, said one astronomer, across a dim recess in such a cave would remain perfect and unchanged for a million years.

This is not a very promising picture for the existence of living things. At first glance, it would seem that the conditions on the moon would be fatal to any kind of native life. But over the years, scientists have not been satisfied with this first glance. They have insisted upon taking a closer look.

Almost 40 years ago, William H. Pickering, then professor of astronomy at Harvard University in Boston and one of our leading selenographers, thought the moon could have life. He based his argument on the observations he had made during a lifetime devoted to careful and painstaking study of the moon. He said:

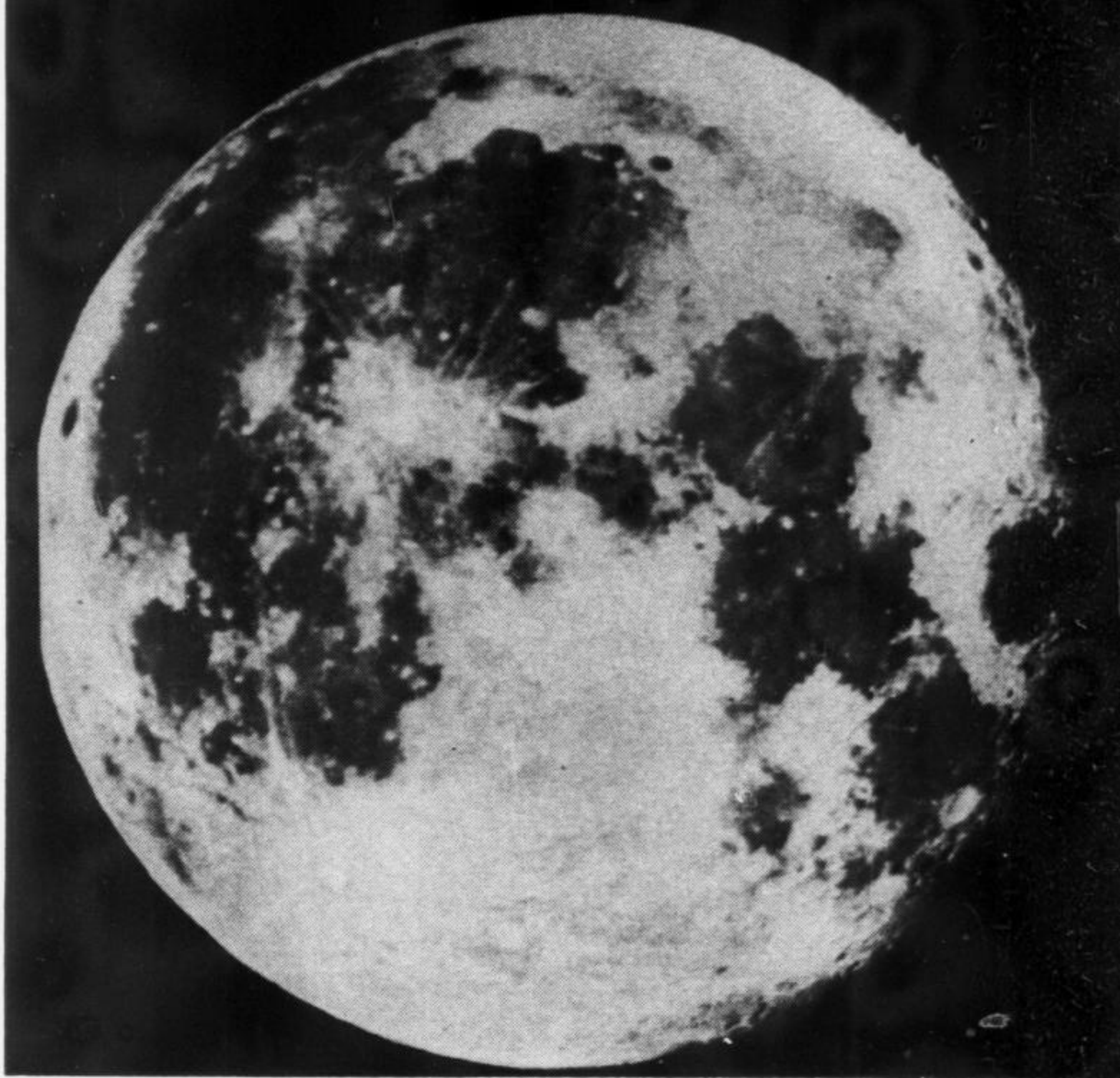
"The view that the moon is a dead unchanging world . . . is so widespread and so firmly rooted in the minds of not only the general public, but of the astronomical world as well, that the practically unanimous opinions of all the great selenographers has been able to make but little impression on it . . . The arguments on the two sides of the case are very simple. The astronomers who are not selenographers declare that there is no atmosphere or water on the moon and that, therefore, changes and life are impossible. The selenographer's reply is simply that they have seen changes take place on the moon."

Today, observations with better telescopes and instruments lend support to Pickering's ideas. Recent findings have convinced many astronomers that the moon is very far from being a dead and inactive body.

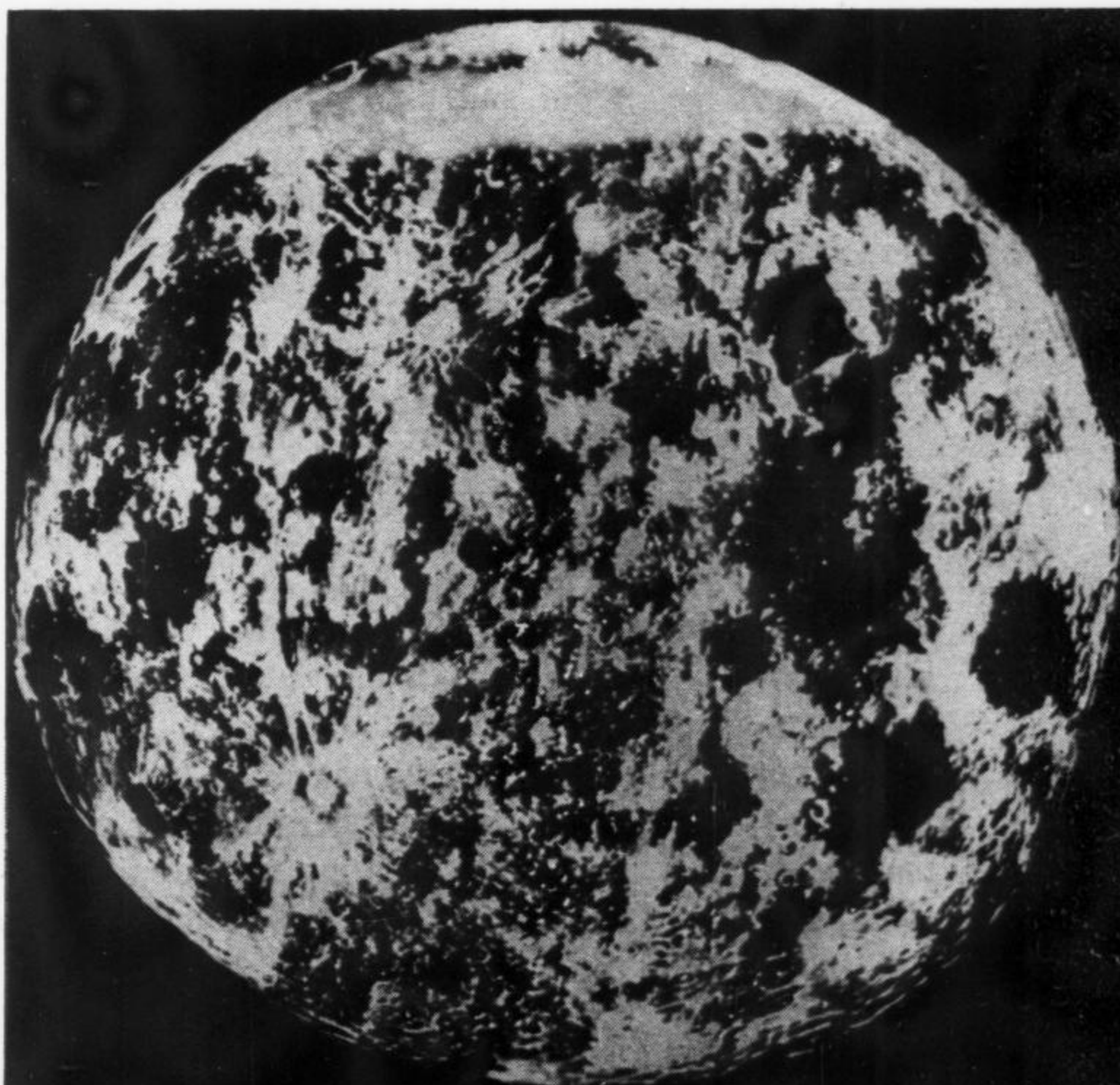
These changes that take place on the moon, how-

continued on next page

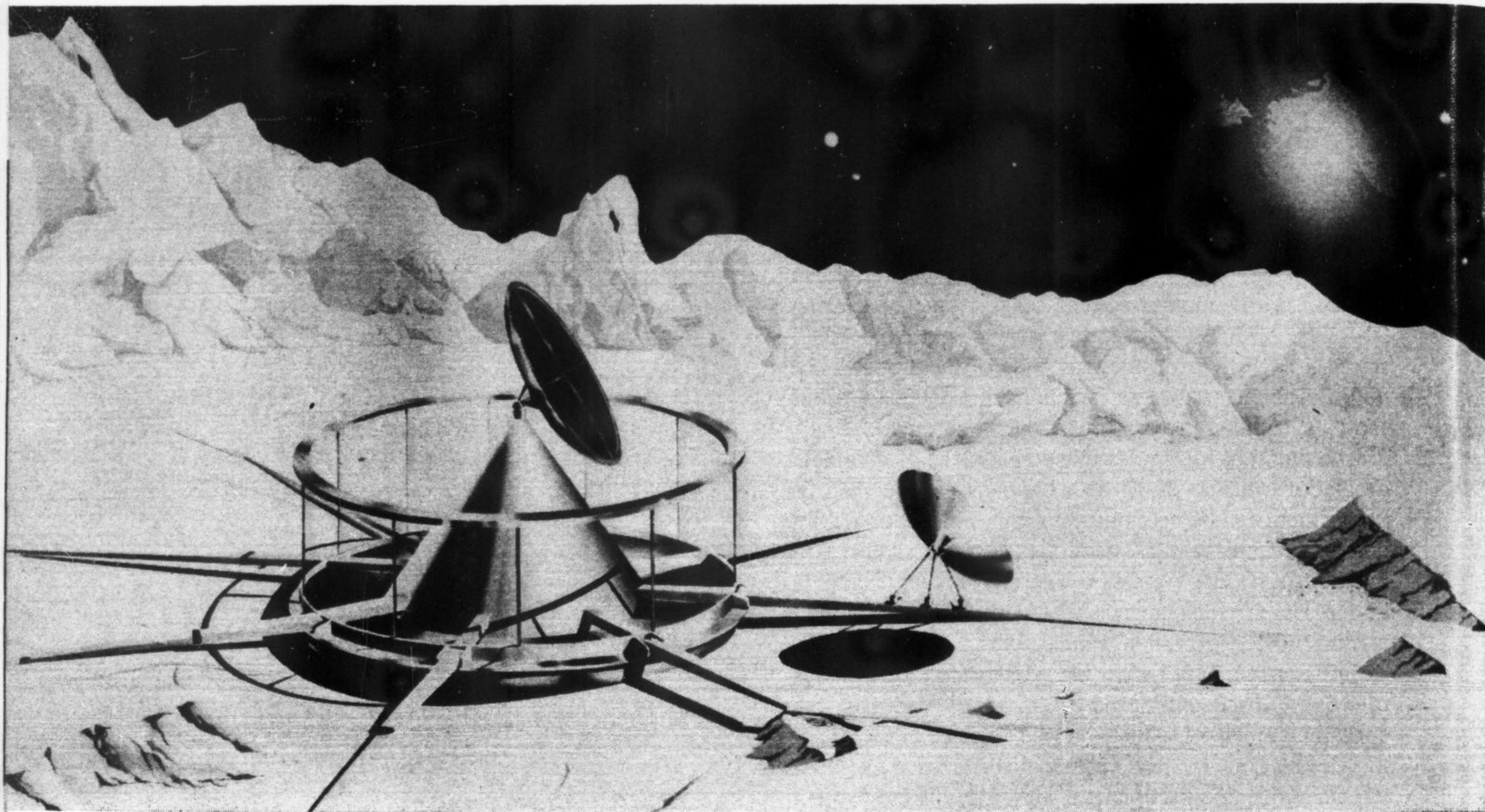
Lunar Landing. Astronomers all over the world are making an intensive study of the moon in preparation for manned lunar expeditions. President Kennedy has set the year 1970 as target date for three-man Apollo mission to the moon.



*Modern techniques of radar and
telescopic investigation reveal
some very surprising facts
about living conditions on our
'dead and forbidding' satellite*



Some astronomers believe that men will



Unmanned Lunar Probe. A series of unmanned probes are scheduled to land on the moon before manned attempts are made. These probes will investigate lunar conditions at first hand.

ever, have been very hard to see. One of the reasons for this is because of the moon's position relative to the sun. It turns on its axis only once every 27 days—one day on the moon is equal to 27 days on the earth—which is exactly equal to the time the moon takes to swing around the earth. That is why we can only see one side of the moon, and that is why there are no seasons there.

There is no real spring, summer, autumn or winter on the moon. Instead, these seasons are part of the 27-day sunlight cycle. They depend on the play of light and shadow as the sun rolls slowly across the moon's black sky during its long day.

Yet, within the passage of this moon day, what could be called seasonal changes have been witnessed by astronomers. They have seen features on the moon darken, and others turn pale. Still others grow and shrink and change their color in the course of this long lunar day.

The strangest thing about these changes is that they do not keep step with changes in temperature that can be measured between the lunar morning and evening. Instead, these seasonal changes lag behind the sun two

or three days. They seem to keep step with temperatures that scientists expect to find below the surface of the moon, and must depend on conditions below the lunar ground.

If so, then these changes must be the result of vegetation that sends long taproots down below the surface. This would explain the lag behind the sun. But how can we prove it?

It will be very hard to find proof. Temperatures on the moon, for example, are very harsh. They range from 214 degrees Fahrenheit, above the boiling point of water, in the direct sunlight at the equator, to below 243 degrees, a temperature where air turns into a liquid, on the dark side of the moon. This temperature range is far crueller than anything on earth (140 degrees at the equator to -150 degrees in the antarctic) and far greater than the temperature tolerance of any kind of life that lives on earth.

Before we come to any final conclusion, however, let's take another look at these lunar temperatures. We know that the material on the top of the moon is light and porous, a very good insulator that acts just like the insulation we put in houses on earth so that they won't get too hot or too cold.

find life on the moon

And we also know that two feet below the surface of the moon the temperatures are much milder than on the surface. In fact, a new technique allows us to actually measure the temperatures below the surface of the moon.

This is done by bouncing radio waves off the surface of the moon. Unlike light waves, that are reflected from the surface, the radio waves penetrate below. How deep they go is controlled by the wave length of the radio signal. By comparing this reflected radio wave with what was first sent to the moon, we are able to measure temperatures below the surface.

Only two feet below the moon's top, temperatures are much steadier and they don't go up and down more than 80 degrees. But even on the surface of the moon, scientists have found spots where temperatures are not so high or low. Because of the play of sunlight and shadow on craters and mountains, local climates and atmospheres are made. The temperature within the walls of the crater Copernicus, which is almost on the moon's equator, is far lower than the temperatures surrounding it because of this play of shadow.

And these local climates are made wherever there is a walled spot, or a cleft or a hollow in the low areas of the moon's flat plains. Within these protected spots atmospheres are made just like they are made in closed terrariums.

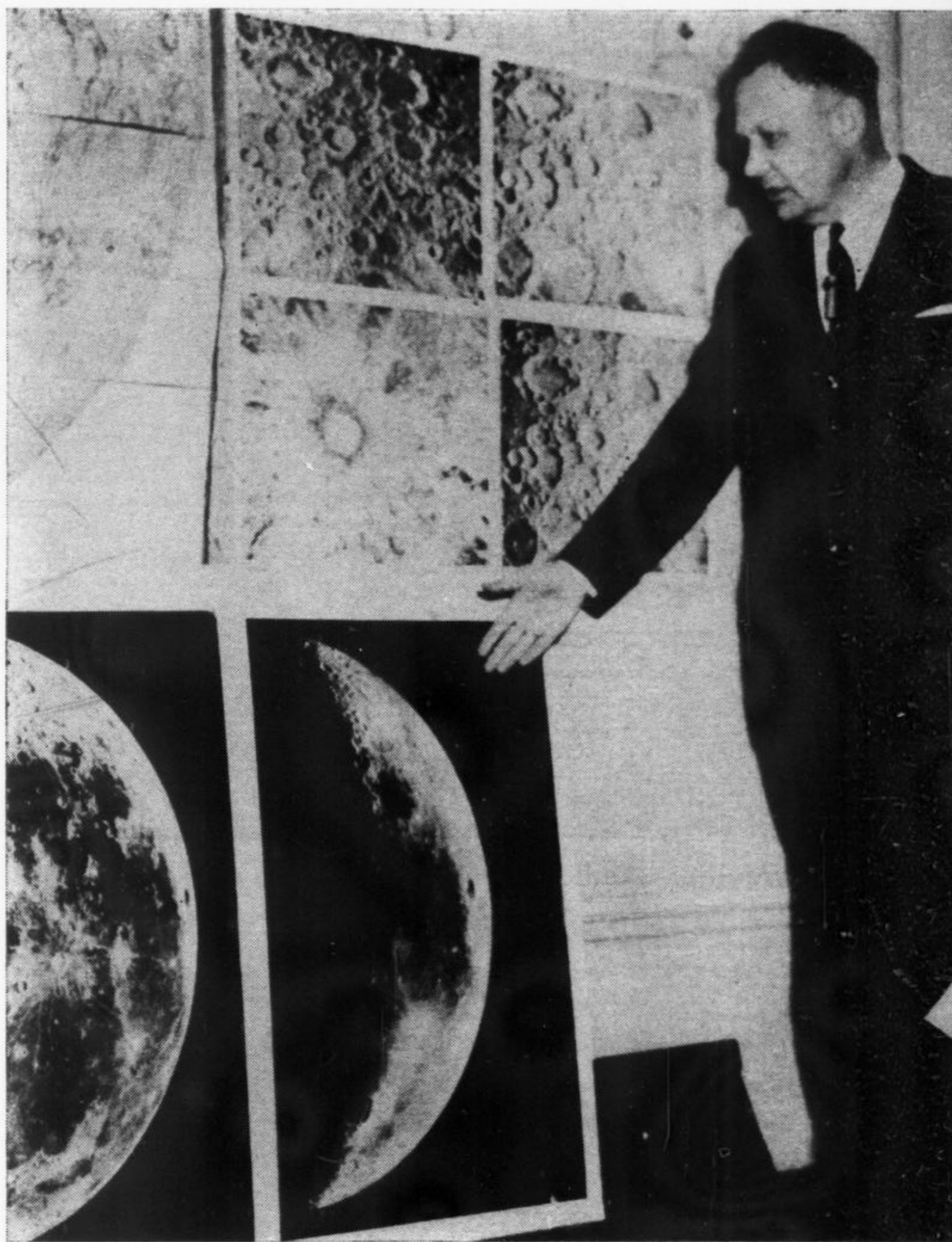
Within such special spots on the moon, many scientists believe, life may have secured a foothold. This life will probably be a very simple form of plant or fungus. But it could have evolved into forms that are completely different from anything we know on earth.

What evidence, though, is there that life developed even in these protected local spots?

"The differences of shade and color between neighboring areas on parts of the moon," says British astronomer V. A. Firsoff, "look suspiciously like a living growth of some kind."

And many other astronomers agree. Patrick Moore, a noted Irish selenographer, for example, says that the round colored bands that run around certain crater walls may be caused by vegetation. These plants, he explains, could have sprung up along invisible breaks in the lunar crust through which life-sustaining gases and vapours from the moon's interior escape.

Such an area occurs in the Mare Tranquillitatis, near the center of the moon. Here, astronomers have noticed large colored patches. The largest of these blue-green spots runs over a range of hills. When you compare these colored spots with the hills surrounding them, you can easily see that the marks are definitely due to something on the surface of the rocks. Some astronomers say that these patches are growths of vegetation.



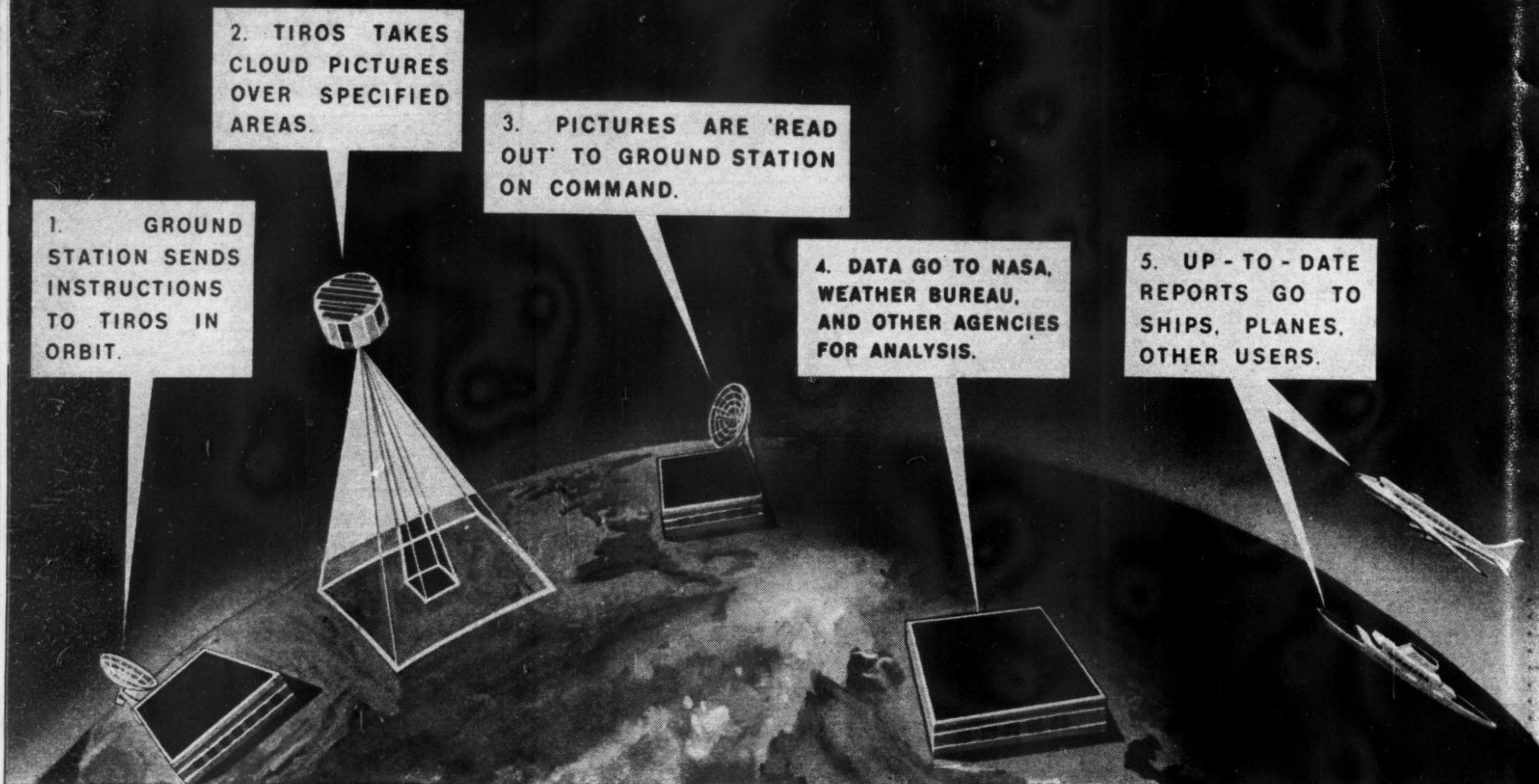
Lunar Atlas. Dr. Gerald Kuiper, has compiled a comprehensive atlas of the moon to aid future exploring parties.

Within the walls of the crater Eratosthenes, still another strange effect has been witnessed. A whole series of dark markings in this area have been seen to grow during the course of a lunar day at the rate of six inches an hour. It is not too likely that these marks are animals moving across the moon, but they could be fast-growing plants.

We have seen that though the temperatures on the moon are fatal to life, there are spots where temperatures are not so deadly, although they are still extreme when compared to earth. Life then, if it exists on the moon, must have learned how to survive this rugged climate.

We also know that the atmosphere on the moon is very thin, as thin, in fact, as the best vacuum we can produce here on earth. And even this wispy atmosphere occurs only during the lunar morning when the rays of the sun vaporize sulphur, bromides, mercury and other such matter that exists in the surface rocks. Moon life then, must have learned how to stand up to vacuum-like conditions.

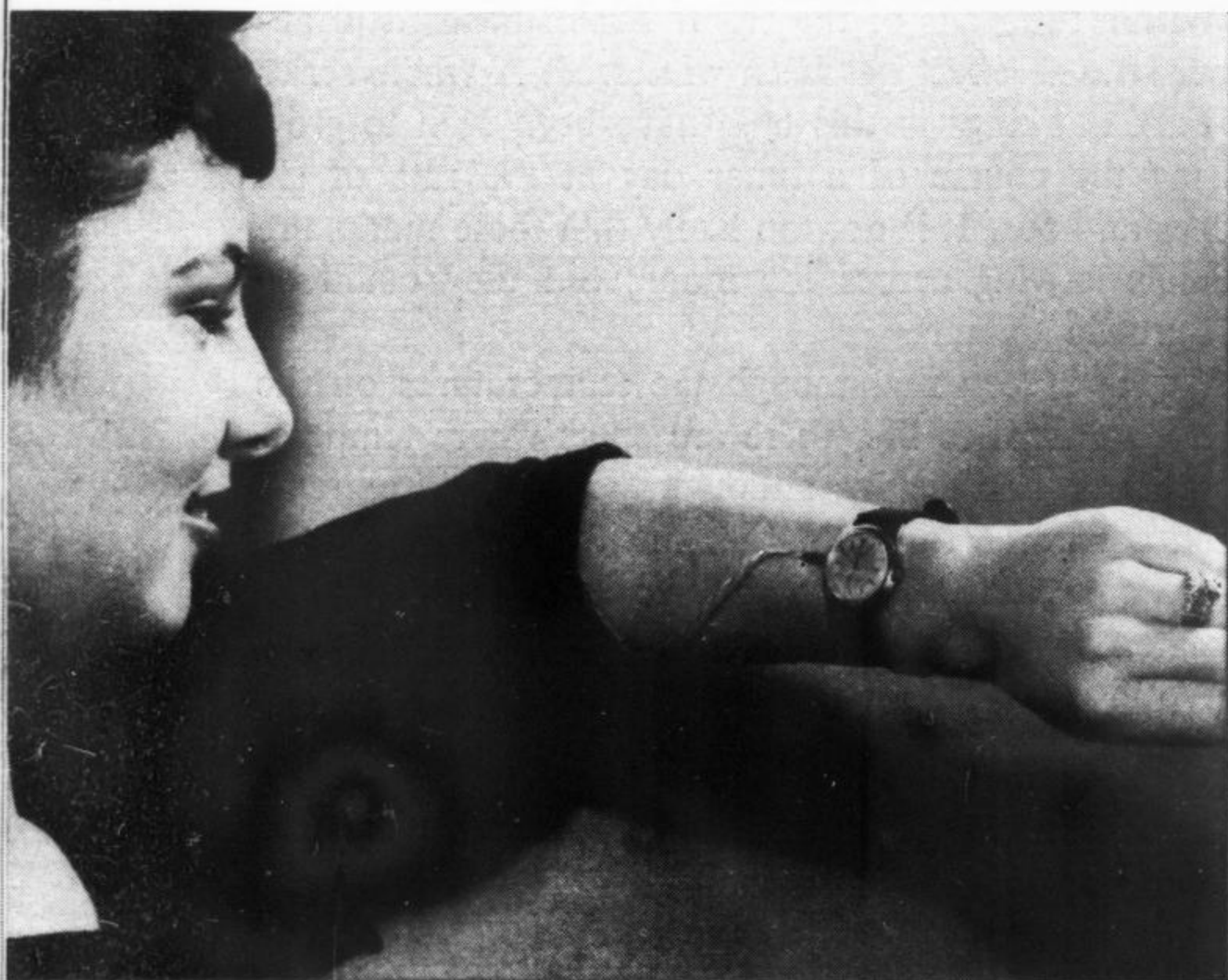
Also, because of this lack of atmosphere, the un-
(continued on page 49)



Weather Predictions. Cloud-scanning satellites will help make weather forecasts more reliable than ever before.

What's In Space

A list of benefits that space science is bringing to you



Heart Beat Totalizer. Using space miniaturization methods, this device keeps accurate count of a patient's heart-beat.

Within the next 10 years, the United States will spend up to \$50 billion for both the civil and military space programs. Sooner or later, what our venturesome space scientists learn will affect all our lives—the farmer and the industrial worker on his job, the housewife, the teen-ager at school, doctors, business executives, every citizen.

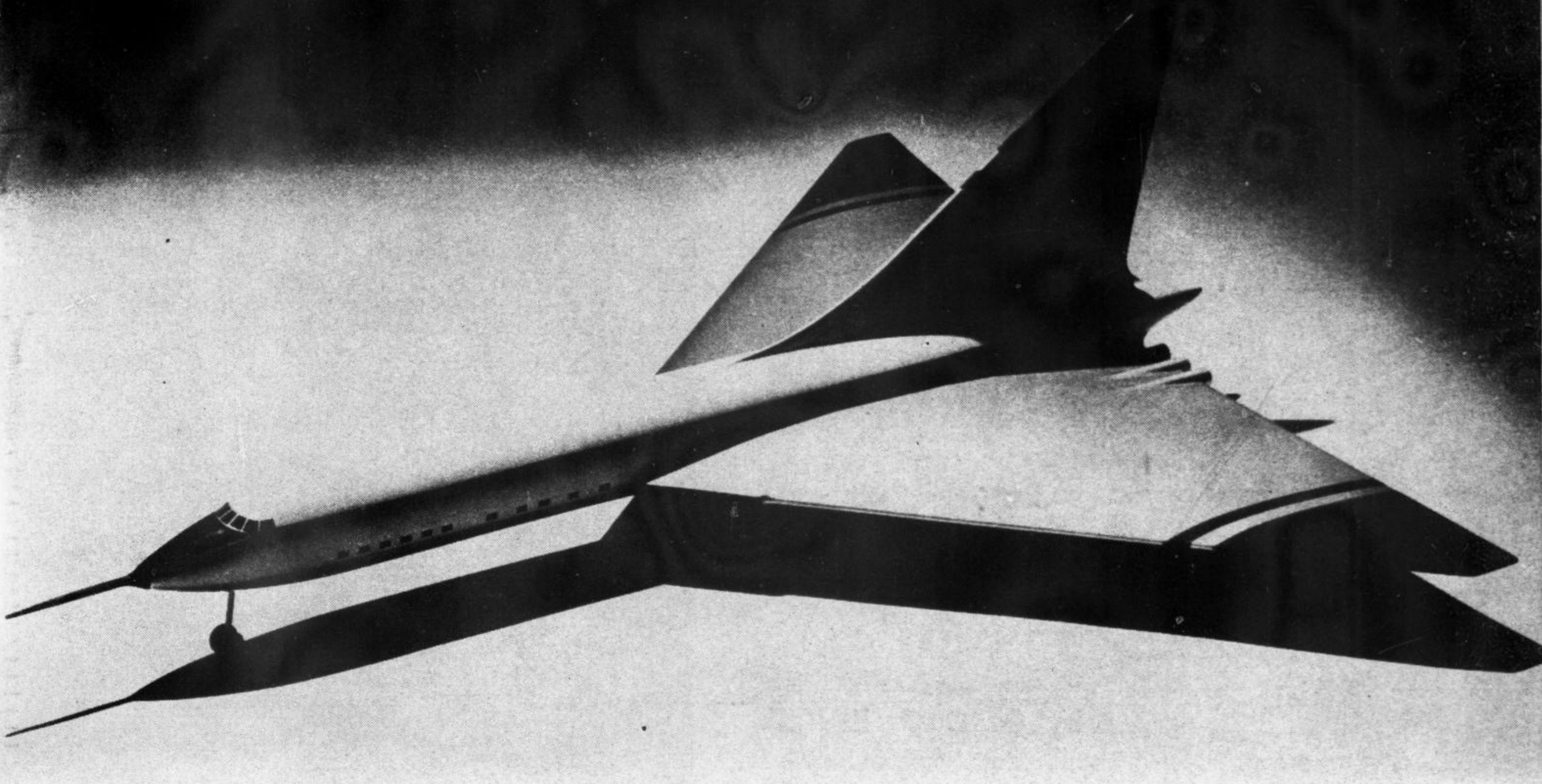
Here, at a glance, are some of the non-military pay-offs we can reasonably expect of our space research and exploration, a small part of the treasure-house of new techniques, new materials and inventions:

Space Communications

On August 12, 1960, NASA's Echo I satellite, a large inflatable sphere, proved it was practical to communicate via an artificial satellite.

On August 18, 1960, the first trans-Atlantic wireless-code transmission was completed via Echo I from the Bell labs to a station at Issy-les-Moulineaux, France.

On August 22, space scientists bounced the first trans-Atlantic voice message off Echo I—a description of the Echo experiment. They also transmitted a recording of "America the Beautiful" from Holmdel to listeners in Jodrell Bank, England.



Supersonic Planes. Techniques of rocket and missile operation will be applied to commercial aviation for super-carriers.

For You?

On November 10, 1960, NASA assisted the Post Office Department in an experiment to determine the possible use of satellites for the transmission of Speedmail. A letter, urging the public to send Christmas presents early, was bounced off Echo from Stump Neck, Maryland to Newark, N.J.—*the first letter to be processed through outer space.*

In education, relay satellites would make possible “live” regional presentation of lectures and special events, which now must be taped and distributed singly to schools and local transmitters.

Finally, a world radio and TV network should foster better understanding between all peoples and nations on earth.

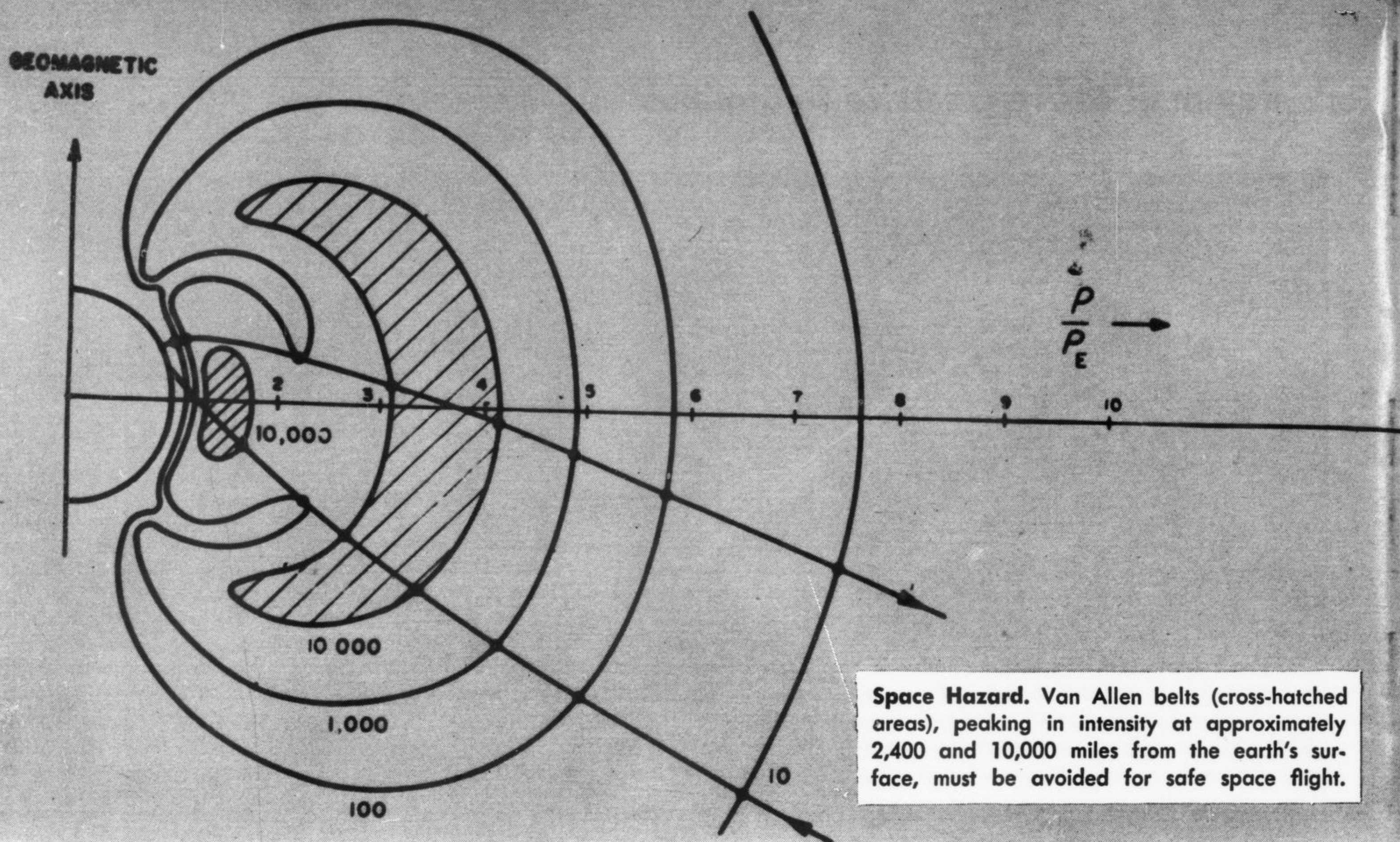
Weather Orbiters

The meteorological satellite Tiros I transmitted 22,952 TV-scenes of earth’s cloud cover up until June 17, 1960. Our Tiros II, launched November 23, 1960, is still active in reporting a whole new spectrum of atmospheric and solar heat radiation data affecting climate and weather.

The Nimbus series will follow the Tiros series in mid-1962. Planned for sometime in 1964 is the Aeros satel-
(continued on page 46)



Communication Satellite. Courier is prototype for system that will provide radio contact between any two points.



INDEXED BY P.A.L.

SAFE ROUTES FOR MANNED

A Soviet academician discusses high-energy particles in space

At the present time we know two ways in which man can penetrate outer space. First, outer space can be studied and explored for distances of hundreds of millions of kilometres with the help of automatic devices connected with the earth by radio.

Telemechanics and remote control will make it possible to carry out in space all the operations which a space pilot would supervise personally. For instance, an apparatus equipped with a TV set and automatic hands, radio-controlled from the earth, will be carried to the surface of the moon. This unit will copy the movements of the hands of the operator on earth, as is done in "hot laboratories" when working with radioactive isotopes.

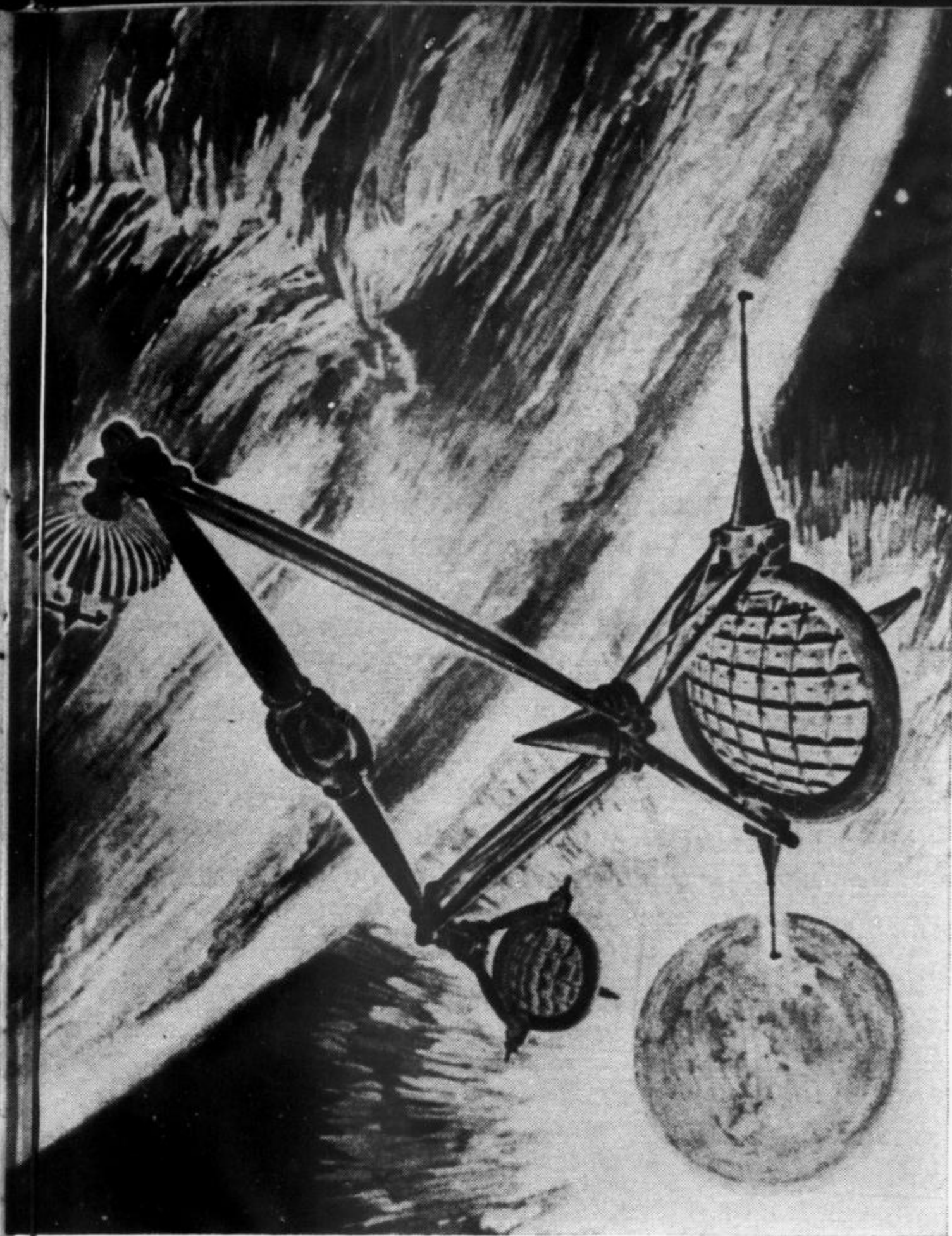
The operator on earth, watching the screen of a TV set, would control the mechanical hands in the same way as though working on earth with terrestrial installations.

The only inconvenience here would be a slight lag due to the fact that the passage of the radio waves from the earth to the moon and the visual image from the moon to the earth would take about 2.5 seconds.

It is obvious that cosmic automation will continue to develop as an important and independent method of space science and engineering. But at the same time, just as it is the only way of studying outer space, it cannot be considered the chief trend in this field. Automation can only function according to a definite, previously drawnup programme. As long as only automatic means of research penetrate outer space, many specific features of this vacuum and of the heavenly bodies may remain unrecorded for a long time.

In order to accelerate the study of outer space man must be given the opportunity of becoming accustomed to the space environment. The development of space flights has now become an important factor for the further success of space researches.

The greatest danger threatening man in outer space is presented by the streams of high-energy particles, capable of piercing massive obstacles. On the earth man is protected against these particles by the great mass of the atmosphere, equivalent to a layer of water 10 metres thick.



Sputnik. Future Soviet satellite designed for space observation to measure high-energy particles.

SPACE FLIGHT

by **GEORGY POKROVSKY**

To provide such a protective layer on a space ship is almost impossible, for even with the use of the most economical materials, the weight of such a barrier would exceed the lifting power of space ships of the near future. Therefore, the flight of a manned space ship must be charted along routes where the action of high energy particles would be either excluded or reduced to the minimum.

The chief streams dangerous to man can be divided into two groups. First of all, there are two rings encircling the globe in the plane of the equator. This type of high-energy particles has been discovered thanks to the researches of a group of Soviet scientists headed by V. N. Vernov and a group of American scientists working under the guidance of Van Allen.

The second group consists of the streams of high-energy particles emitted by solar flares on the Sun from time to time. These streams frequently appear during the periods of intense solar activity. The periods of maximum solar activity usually occur at intervals of 11 years. The last such period was in 1955-1958.

At present, a period of reduced activity has set in

and will last for several years, until 1965-1966. During these years the streams of particles of the second group will be met with rarely and will be of low intensity. This is the period which can be utilized to carry out an extensive programme of space flights.

Generalizing the data at the disposal of modern science, safe routes for a manned space flight can be charted during the following periods:

A. During the period of low solar activity:

1. Flights can be made over all parts of the earth at altitudes of up to 1,000 km. (620 miles). At higher altitudes flight cannot be made in the central and equatorial latitudes because of the rings of high-energy particles met with there.

2. Flights to remote zones of outer space and subsequent re-entry can only be accomplished through channels following the line of the earth's axis and adjacent to the Arctic and Antarctic regions.

3. Beyond the limits of approximately 50,000 km (30,000 miles) flights can be made in different directions.

4. When approaching the larger planets, which must have magnetic fields resembling that of the earth, the surface of such planets should be approached by channels lying in the vicinity of their axes. When making flights to heavenly bodies considerably smaller than the earth, to the moon for instance, these precautions will probably not be necessary because such bodies may have no magnetic field or rings of high-energy particles.

B. During the period of high solar activity the opportunities for space flights are considerably reduced. In this case space flights can only be made up to the altitude of 1,000 km. above the earth's surface.

It is not excluded that during a flight through space, pilots wearing special space suits will make excursions to outer space, leaving the space ship by special ports. The present level of technology makes it possible for the space suits to include all the apparatus required for a normal flight of man in conditions of weightlessness.

It should, however, be borne in mind that in the vicinity of a sputnik travelling relatively near to the earth there is no absolute zero gravity. All the bodies moving with the sputnik experience the action of "tidal" forces, so-called because they are analogous to the forces created by the tides of the earth's oceans.

Bodies situated below the centre of gravity of the space ship are drawn from it to the earth. On the other hand bodies above the centre of gravity of the ship are drawn from the ship into the depth of outer space.

(continued on page 62)